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TRANSACTIONS

OF THE

AMERICAN ORTHOPEDIC ASSOCIATION.

TWELFTH SESSION,

HELD AT BOSTON, MASS.,

MAY 17, 18, AND 19, 1898.

VOLUME XI.

PHILADELPHIA:
PUBLISHED BY THE ASSOCIATION.
1898.

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DORNAN, PRINTER,
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* Original Members.

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1892. BLANCHARD, WALLACE, M.D. Attending Orthopedic Surgeon to the Home for Destitute Crippled Children. 34 E. Monroe Street, Chicago.

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1890. WILLIAM MACEWEN, M.D., LL.D., Professor of Clinical Surgery and Surgeon to the Glasgow Royal Infirmary; Surgeon to the Royal Hospital for Sick Children. 3 Woodside Crescent, Glasgow, Scotland.

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1890. DR. A. HOFFA, Privatdocent der Chirurgie an der Universität Würzburg. Sieboldstrasse 10, Würzburg.

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ELECTED

1889. HOWARD MARSH, F.R.C.S. ENG., Senior Assistant Surgeon and Lecturer on Surgery, St. Bartholomew's Hospital; Consulting Surgeon, Hospital for Sick Children, and Alexandra Hospital for Hip Disease. 30 Bruton Street, W., London, England.

1890. EDMUND OWEN, M.B., F.R.C.S., Surgeon to and Joint Lecturer on Surgery at St. Mary's Hospital; Senior Surgeon to the Hospital for Sick Children, Great Ormond Street. 64 Great Cumberland Place, W., London, England.

1892. PIETRO PANZERI, M.D., Direttore di Istitutio dei Rachitici, Milano. Via S. Calimero 31, Milano, Italy.

1892. ROBERT WILLIAM PARKER, M.R.C.S. ENG., Senior Surgeon, East London Hospital for Children; Surgeon, German Hospital, Dalston. 13 Welbeck Street, W., London, England.

1890. PAUL REDARD, M.D., Lauréat de l'Institut; Ancien Chef de Clinique Chirurgicale de la Faculté de Médecine de Paris; Chirurgien du Dispensaire Furtado-Heine. 3 Rue de Turin, Paris, France.

1888. BERNARD ROTH, F.R.C.S. ENG. 29 Queen Anne Street, Cavendish Square, W., London, England.

1890. NOBLE SMITH, F.R.C.S. EDIN., L.R.C.P. LOND., M.R.C.S. ENG., M.D., Surgeon to All Saints' Children's Hospital; Orthopedic Surgeon to British Home for Incurables. 24 Queen Anne Street, Cavendish Square, W., London, England.

1890. W. J. WALSHAM, F.R.C.S. ENG., M.B. and C.M. ABERDEEN, Assistant Surgeon and Surgeon-in-Charge of Orthopedic Department, and Lecturer on Anatomy, St. Bartholomew's Hospital; Surgeon, Metropolitan Hospital; Consulting Surgeon to Hospital for Hip Diseases, Sevenoaks, and to the Burnley Cottage Hospital. 77 Harley Street, London, England.

1890. GEORGE ARTHUR WRIGHT, B.A., M.B. OXON., F.R.C.S., Senior Assistant Surgeon, Royal Infirmary, Manchester; Surgeon to Children's Hospital, Pendlebury and Manchester. 8A St. John Street, Manchester, England.

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CONSTITUTION AND BY-LAWS.

CONSTITUTION.

ARTICLE I.—NAME.

THIS Society shall be called the "AMERICAN ORTHOPEDIC ASSOCIATION."

ARTICLE II.—OBJECT.

The purpose of this Association shall be the advancement of orthopedic science and art.

ARTICLE III.—MEMBERSHIP.

SECTION 1. The members shall be graduates of regular medical schools, shall be in good professional standing, and shall be especially interested in Orthopedic Surgery.

SEC. 2. There shall be three classes of members, viz.: Acting, Corresponding, and Honorary.

SEC. 3. The number of Active Members shall be limited to sixty.

SEC. 4. Candidates for membership shall have been engaged in the practice of medicine for at least five years, and shall have given evidence of satisfactory scientific attainments.

ARTICLE IV.—OFFICERS.

The officers shall consist of a President, a First Vice-President, a Second Vice-President, a Secretary, and a Treasurer, all to be elected annually at the last executive session of a regular meeting.

ARTICLE V.—STANDING COMMITTEES.

There shall be a Committee on Membership, consisting of five members, a Committee on Publication, consisting of three members, and an Executive Committee, consisting of the President, the Secretary, and the Treasurer.

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ARTICLE VI.—ELECTIONS.

All elections shall be by ballot; for officers a majority shall elect, for members a four-fifths majority.

ARTICLE VII.—MEETINGS.

The meetings of the Association shall be Regular and Special.

ARTICLE VIII.—FEES.

Active members shall pay an initiation fee of twenty-five dollars, and annual dues of fifteen dollars.

ARTICLE IX.—PUBLISHED PROCEEDINGS.

The business proceedings of the Association shall be published annually. The papers and discussions shall be published annually, unless the Association otherwise directs at the close of the regular meeting.

ARTICLE X.—DISCIPLINE.

A three-fourths vote of all members present at a regular meeting shall be necessary for suspension or expulsion of a member.

ARTICLE XI.—THE CONGRESS.

SECTION 1. This Association shall hold membership in and meet with the Congress of American Physicians and Surgeons.

SEC. 2. It shall, at the first annual meeting held after the adjournment of any Congress, elect a member to represent it on the Executive Committee of the Congress for the ensuing three years, and it shall also elect a second member as an alternate.

ARTICLE XII.—QUORUM.

An actual presence of nine active members at any one meeting shall be necessary for the transaction of business.

ARTICLE XIII.—AMENDMENTS.

Alterations to this Constitution may be made at any regular meeting by a four-fifths vote of all the members present; provided that notice

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of the proposed changes, signed by two active members, shall have been given to all the active members at least one month previous to final action.

BY-LAWS.

ARTICLE I.—MEMBERSHIP.

SECTION 1. Nominations for membership shall be made in writing, signed by the proposer and seconder, accompanied by evidence as to the fitness of the candidate for fellowship, and shall be placed in the hands of the Secretary at the previous meeting to the time of the regular meeting.

SEC. 2. Candidates for active membership shall, through the Secretary, present a paper to the Association.

SEC. 3. Only those of acknowledged pre-eminence in orthopedic surgery shall be eligible to honorary membership.

SEC. 4. Foreign residents only shall be eligible to corresponding membership.

SEC. 5. All the scientific privileges of the Association shall be accorded to the honorary and corresponding members.

SEC. 6. Membership shall be forfeited when one ceases to take an active interest in the objects of the Association, or is guilty of an unprofessional act or a public misdemeanor. Action in such cases shall be taken according to Article X. of the Constitution.

SEC. 7. An active member absenting himself for three consecutive meetings, or two years in arrears in payment of dues, may be dropped from the rolls.

SEC. 8. All members in attendance at any meeting shall register in a book provided for the purpose.

ARTICLE II.—OFFICERS AND STANDING COMMITTEES.

SECTION 1. The duties of officers and standing committees shall commence after the adjournment of the meeting at which they are elected or appointed, and shall continue until their successors are duly installed.

SEC. 2. The President shall preside at all meetings, shall deliver an annual address, shall appoint a Committee on Membership of five, two of whom shall have served the preceding year, and a Committee on Publication, shall fill any vacancies that may occur from resignation or otherwise.

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SEC. 3. The Vice-President shall act in the absence of the President.

SEC. 4. The Secretary shall give due notice of and keep the minutes of all meetings, shall conduct all correspondence, shall notify candidates of their election to membership, and inform members of their appointment on committees, and shall perform such other duties as are assigned to him by the Association.

SEC. 5. The Treasurer shall collect all moneys due the Association, be the custodian of the same, and pay it out only on warrant signed by the President and Secretary. At the annual meeting he shall make a report of his receipts and expenditures, which, after being duly audited, shall be filed.

SEC. 6. The Membership Committee shall consider the eligibility of all nominees for membership, and shall report its recommendations to the Association.

SEC. 7. The Executive Committee shall make all necessary arrangements for the meetings of the Association, assign the order for scientific work, and report the same to all members as early as practicable before the time of the annual meeting; it shall further manage such necessary affairs of the Association as are not already assigned to others.

SEC. 8. The Publication Committee shall attend to the preparation, publication, and distribution of the annual proceedings of the Association; and shall have discretionary power as to the matter for publication in questionable cases.

ARTICLE III.—ELECTIONS.

Election of members shall be held at the first executive session of a regular meeting, and of officers at the last business session.

ARTICLE IV.—MEETINGS.

SECTION 1. The regular meetings shall be held annually during the third week in September of each year, or at such other time and at such place as the Association may elect. If no action should be taken in the matter, the Executive Committee shall decide.

SEC. 2. Special meetings may be called by the Executive Committee or by the President at the written request of ten active members.

SEC. 3. Every third year the Association shall convene as a part of the Congress of American Physicians and Surgeons.

ARTICLE V.—DUES.

The yearly dues shall be paid to the Treasurer at the time of registration.

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ARTICLE VI.—PUBLISHED PROCEEDINGS.

SECTION 1. The Transactions shall be printed as soon after the adjournment of the regular meeting as possible, and distributed to the members, one copy to each, except to those in arrears on Association dues.

SEC. 2. Additional copies of the Transactions shall be furnished to members at cost, and to the public at a price to be determined by the Publication Committee.

SEC. 3. Authors desiring reprints of their papers will notify the Publication Committee, who shall already have established rates for reprints with the publishers.

SEC. 4. Papers not in the hands of the Secretary within four weeks after adjournment of the meeting shall be omitted from the Transactions on the unanimous vote of the Publication Committee.

ARTICLE VII.—PAPERS AND DISCUSSIONS.

SECTION 1. Papers read before the Association shall be limited to twenty minutes, unless the time be extended by vote. Discussions shall be limited to five-minute speeches. No member shall speak a second time on the same subject if others desire the floor. The author of the paper shall be privileged to close the debate.

SEC. 2. No papers shall be read that have been previously published.

Members publishing their papers after they have been presented to the Association shall designate them, "Read before the American Orthopedic Association." Authors desiring their papers illustrated shall furnish the necessary wood-cuts.

SEC. 3. Proofs sent to authors should be returned within a fortnight, otherwise the matter will go to press without the author's corrections. Marked changes from copy, known as "time-work," shall be paid for by the author.

SEC. 4. Transcripts of the discussion shall be furnished the participants for correction, but not for rewriting.

ARTICLE VIII.—EXECUTIVE.

SECTION 1. Two executive sessions shall be held during each regular annual meeting—to wit: at noon of the first day, and at noon of the last day. The order of business shall be:

1. Reading of unapproved minutes and records.
2. Reports of officers and committees and action thereon.
3. Unfinished business.

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4. Election.
5. New business.

The last act before the adjournment of the last session shall be the reading of unapproved minutes and action thereon. Urgent business may be transacted at any session by unanimous consent.

SEC. 2. The proceedings of the Association shall be in accordance with parliamentary usage.

ARTICLE IX.—AMENDMENTS.

Proposed amendments to the By-laws shall be submitted in writing and signed by two active members. Previous notice of the proposed changes shall be given. A three-fourths affirmative vote of all members present at a regular meeting shall be necessary to ratification.

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THE PRESIDENT'S ADDRESS.

PATHOLOGY IN ITS RELATION TO ORTHOPEDIC SURGERY.

By R. W. LOVETT, M.D.,
BOSTON.

It is my pleasure and privilege to bid you welcome to this, the twelfth annual meeting of our Association. Many of you will recall the questions which arose in 1887 as to advisability of forming this Association, and the opposition which it met in its early days. Time enough has elapsed since then for us to set a critical estimate on its work and its position. The work, to be sure, is our own, and for that reason we are not perhaps the best judges of it; but if we err on the side of being too critical in our attempt to estimate it, no harm can result from the effort. The position of the Association in the medical world speaks for itself. The time is past when any vindication is needed either of the American Orthopedic Association or of American orthopedic surgery.

Twenty-five years ago the first chair of orthopedic surgery was founded in the Bellevue Medical College, and was filled by Dr. Lewis A. Sayre. To-day instruction in orthopedic surgery is announced in the catalogues of at least forty-two of our American medical schools, embracing the prominent ones in Boston, New York, and Philadelphia, as well as others in the South and West. Instruction in orthopedic surgery is given in eleven of our largest cities by twenty-three members of this Association, yet there are some prominent medical schools in which no special instruction is announced in orthopedic surgery, to which I invite your attention. Some of these are as follows: Johns Hopkins University (Baltimore),

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University of Maryland, University of Vermont, University of Michigan, Tulane University. It should be our effort, both by our personal endeavor and by the character of our work, to bring it about that these medical schools shall find necessary such an addition to their course of instruction.

This Association has proved not only a bond of union, but a stimulus to all of us. The ten volumes of its TRANSACTIONS constitute modern American orthopedic literature. All this achievement brings with it responsibility; and we stand as an organization to-day the custodians of the future of orthopedic surgery in America, pledged by our past work to do in the future our very best. We cannot escape the trust; it is ours by right. It is not a responsibility with which we can deal lightly. The situation demands our most careful and thoughtful consideration. If there are respects in which our work can be extended, we must recognize them. If the surrounding conditions have changed, we must realize the fact and adapt ourselves to them.

In looking over our volumes of TRANSACTIONS, one finds papers dealing with the clinical aspect and mechanical and operative treatment of almost every condition known in orthopedic surgery. The ground is thoroughly, practically, and scientifically covered by your work. This fact, and the comparative scarcity of papers on the experimental and pathological side of the subject in these TRANSACTIONS, lead me to suggest to you, what you already appreciate, that there lies ready a field of work of equal importance, which is in need of cultivation. In this matter the conditions have changed of late years, so far as we ourselves are concerned. In the early years of our Association our first duty was very naturally to go over and investigate the treatment and clinical aspect of the common affections that we treat. But now that this has been so thoroughly done, it seems to me that we may pause to ask if, in the natural sequence of events, there is not a new line to be followed in much of our future work, following the lead set us by some of our members in the last two or three years.

Certain general considerations bear on this subject:

General surgery and medicine are advancing rapidly on new lines in the later years. A pathological basis is being sought for, and in certain directions is being established; bacteriology has modified all

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things; serum therapy has arisen, and has accomplished much. A pathological laboratory is a part of the modern hospital outfit. The work in greatest demand is no longer the elaboration of symptoms and the collection of cases, but the work which seeks rather for the causes of symptoms and for the scientific explanation of the conditions found.

The symptoms of malaria are of interest chiefly when interpreted as phases of the life-history of the organisms that cause them. Here, for example, study is directed, not to the symptoms, but to what they mean.

Anæmia is no longer discussed in the light of its symptoms, but in the more intelligent terms of a blood-count. Peritonitis is not any longer spoken of as a vague idiopathic condition so much as the result of certain individual processes which are carefully sought for at autopsy, so that another time the symptoms may be more accurately interpreted in pathological terms, in time, if possible, for successful surgical intervention.

The practical medical world is seeking for causes more every year in the autopsy-room and in the laboratory. American orthopedic surgery cannot escape, nor has it escaped, this tendency; we, too, must progress by an elaboration of the pathological basis, and this line of work naturally falls on us.

When most of us were receiving our medical education pathology was not particularly prominent, and we had comparatively poor facilities for fitting ourselves in this branch. When modern orthopedic surgery received its impetus from Sayre and Taylor there was little or no pathology of joint disease or bone tuberculosis, and they bent their energies to the mechanical and practical side; they shaped American orthopedic surgery, and it still feels their impetus, and has followed their lead in great part. But the conditions have changed; a pathology has been elaborated, and its relative importance is vastly greater. To elaborate the real basis of our specialty —of any specialty—is one of the lines on which the best progress is made; without a pathological basis the best scientific work cannot be accomplished.

As orthopedic surgeons where our knowledge of underlying conditions is vague, we disagree as to therapeutic measures, and our results are less certain than where we know accurately the

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pathological conditions with which we are dealing. As an example of the class where our pathological knowledge is wanting in accuracy and detail, take hip disease. We know, and we have had formulated for us, the general process going on in the hip-joint; but what we know came rather from the work of König, Volkmann, Krause, Lannelongue, G. A. Wright, and others, than from our own pens. An immense number of cases of hip disease must yearly come under the care of members of this Association, yet no important addition to our knowledge of the pathology of hip disease has been made since Gibney's book appeared, fourteen years ago. We have not yet learned to put together clinical phenomena and pathological findings; we do not yet know, for example, what acute malposition of the hip means in pathological language—why one hip should be everted and another flexed. Of the symptoms and cause of acetabular hip disease we know next to nothing. Instances have occurred where, in cases severe enough to demand excision, the head of the femur has been removed and the acetabulum left, and pathological examination has shown that the head of the femur was never the cause of the disease, but that it was acetabular from the first. Certain surgeons assert their ability to diagnosticate acetabular hip disease, but this ability is disclaimed by those whose opinion has most weight with us. We lack here, as we lack at many points in orthopedic surgery, that exact pathological knowledge which would interpret for us clinical phenomena—our indications for excision of the hip are hazy, chiefly, I think, because we do not know just what certain symptoms mean in pathological language.

As an example of the class of subjects where our pathological knowledge is accurate, turn for a moment to one of the most satisfactory operations in orthopedic surgery, the correction of severe club-foot. We are fairly well agreed as to indications for operation; we differ somewhat in details, but in general our procedure is much the same; our results are admirable, almost unimormly so. But here we know with just what we are dealing; the bony changes are formulated. Any book on orthopedic surgery figures the bones; the clinical phenomena fit with the pathological changes. Precision and success mark our work under these conditions.

There are few problems in surgery or medicine more interesting

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or more in need of investigation than those which lie at the root of many of those conditions which, as orthopedic surgeons, we constantly meet. Some of those are conditions which, in certain aspects, attract the attention of the general surgeon or the physician or the neurologist; others depend almost wholly upon ourselves for their elucidation. Of these conditions which demand our investigation it seems to me that first comes the need of better pathological knowledge of inflamed, irritated, and neurasthenic joints, especially joints affected by rheumatoid arthritis and syphilis. Joint tuberculosis comes next in its demand for the further search as to its methods of invasion and extension, and especially for an exact pathological interpretation of common symptoms.

Of the real pathological condition which causes flat-foot, in its early stages, we know very little, and with regard to static deformities there is very much to be done in the way of acquiring precise knowledge.

We know next to nothing as to the determination of the causation of the deformities in rickets and their prevention, and very little as to the real cause of the bony changes in rickets. Infantile paralysis stands in need of investigation as to its possibly infectious character and its etiological cause.

There is no need of the formulation of further defects in our knowledge; you know them as well as I. The present spirit of progress in medicine and surgery demands exact pathological knowledge and the scientific demonstration that certain symptoms are associated with certain lesions. That must form part of our work.

If I have stated the case fairly, and I have tried to be overcritical in speaking of our own work, there is a chance for us to contribute most valuably to orthopedic surgery, not only in the same lines as before, but particularly by the development of lines of work seeking for the causes and pathology of the affections that we treat.

It is obvious that we cannot, as a rule, educate ourselves at this date into being expert pathologists or bacteriologists. We have, as a rule, neither the time nor the opportunity; we have other demands upon our time, and we should not do it well; we could not compete in technique or thoroughness with the better class of young men leaving our medical schools every year. To educate ourselves to a

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point where our opinion would be of value, for instance, in the examination of a section of tuberculous bone, means months or years of work. It presupposes a training in modern histology and an understanding of degenerative, inflammatory, and reparative processes as a preliminary to approaching the study of bone tuberculosis. Where we are so circumstanced that we can acquire this training, or where some of you already have it, the road is clear. But with most of us the detail must be done by other hands.

Having once determined that our operative material, at least, shall be used for pathological purposes, it is not generally hard to find trained assistance in bacteriology and pathology. Young men are at hand almost everywhere, and never was there a better opportunity for them to do creditable work than in these fields of which I have been speaking. We must know enough pathology to direct the work and formulate the lines of investigation, as well as to set a value on the results.

It seems to me, next, that we should scrutinize most closely applicants for membership in this Association, and should insist on a basis of scientific training and acquirement. Realizing that it is not in the power of many of us to do this sort of work in the laboratory unaided, we should select from among our applicants at least some who, by their scientific training and work, are likely to be contributors in this regard to American orthopedic surgery. All this presupposes, however, on our part united action and a certain change of attitude. American orthopedic surgery stands pre-eminent on its mechanical and practical side. My plea to-day is for a working out of a more exact scientific basis than we now have, which can only come from accurate etiological and pathological knowledge. Elaboration of this line of work would, it seems to me, make us not only contributors in a wider sense, but dignify and broaden the specialty.

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TRAUMATISMS OF THE SPINE SIMULATING POTT'S DISEASE.

By T. HALSTED MYERS, M.D.,
NEW YORK CITY.

I HAVE ventured to bring this subject before you for discussion, because I have seen several cases of traumatic osteitis in which I had some difficulty in excluding Pott's disease. If there are such cases, especially if there are any considerable number of them, it is time they should receive more attention than has been given them thus far.

I believe that all the members of this Association probably have such a clear picture of tubercular osteitis of the vertebra in their minds that they would notice any variations from the ordinary course of the disease; but there are many men, general surgeons, insurance examiners, physicians called to testify in accident cases, etc., who do not see so many of these cases as we do, and who might very naturally be led to wrong conclusions by the symptoms presented.

Of course, there are many cases of traumatisms of the spine in which the diagnosis is clear. There has evidently been a dislocation or a fracture of the vertebra. The cord, perhaps, has been more or less severely injured also, and the ensuing paralysis may obscure the symptoms due to the lesion of the bone itself. The clinical picture, however, bears no resemblance to a case of Pott's disease.

Then there is a very large class of cases in which a traumatism is followed within a few days or weeks by symptoms of Pott's disease, and which the subsequent history proves to be this disease. I shall not refer to either of these classes.

The cases to which I wish to call your attention are those in which the traumatism is followed by such symptoms or by such deformity as is most commonly found in Pott's disease, and yet which are proved by the subsequent history not to be tubercular.

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Injuries to the vertebræ are usually the result of indirect violence. Of course, there are numerous instances of kicks, blows upon the back, falls against projecting objects, etc., but the great majority are the result of falls which bend the head or trunk forcibly in some direction. The cervical vertebræ and the lumbar are most vulnerable naturally, as the upper ten dorsal vertebræ are ably protected and solidified by the ribs. Where a rigid part of the spine joins a less rigid part, there seems to be a special liability to injury from these bendings—*i. e.*, the upper and lower cervical regions, as they join the cranium and thorax respectively; the eleventh and twelfth dorsal and first lumbar, at the lower end of the thorax; and the fifth lumbar, adjoining the sacrum.

These remarks do not apply so well to very young children as to adults, as I have twice *tried* to produce a fracture or dislocation in the bodies of children a year old by forcible anterior flexions, and failed. Their spines were too flexible. None of the cases which I have observed have been in very young children, and most of them have been in adults.

I will give the histories of a few cases to illustrate the points I wish to make.

D. S., aged eight years, February 7, 1890. Good family history. Perfectly well until injury. Fell down seven steps, striking head on floor. After four hours in bed he went about again, complaining of headache, stiff neck, and pain in right shoulder. Examination on sixth day showed slight prominence of fifth and sixth cervical spines, and a dorsal curve to left; drooping of right shoulder; swelling above right scapula; slight limitation of flexion and of rotation of head to left. No spinal-cord symptoms. Dr. Shaffer also saw the case, and thought, as I did, the boy in need of mechanical support. Three weeks later the pain had disappeared, with most of the limitation of motion and some of the deformity. He wore the spinal assist and chin-piece less than three months. Spine then straight, motions of head free, no pain, and kyphosis less evident. No further symptoms.

M. B., aged fourteen years, diving in surf injured neck, and a wry-neck position was soon noted; whether it occurred at the time

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of the accident or not was not known. He had, however, no mechanical treatment until I saw him, nearly a year later. Then the head was rotated to left and inclined toward left shoulder. Motions of the head were limited and painful. General health good. A spinal assist and chin-piece were worn for a year, with 50 per cent. improvement in position and cessation of all pain.

The question was at first in both these cases when I saw them, some time after the injury, whether the limitation of motion was due to reflex spasm or to a purely mechanical cause. There was mechanical resistance surely, but was the additional pain on motion and resistance voluntary or involuntary? The proper treatment was evidently protection, whether there was a simple inflammation of the periosteum or bone, or a tubercular process, but it was not so easy to give a reliable prognosis to the anxious parents. As a matter of fact, the first case recovered perfectly in a few months, while the second required a year to secure a cure, and then the deformity was but partially corrected.

While the dorsal region of the spine is the most frequent seat of Pott's disease, I do not recall a case, and did not find one in the case-books of the New York Orthopedic Dispensary, which I looked over from 1890 to 1896 inclusive, in which a traumatism, without spinal-cord lesions or subsequent tubercular infection, was followed by a kyphosis with the symptoms and history of a *simple* osteitis only. In other words, the spine is so strongly protected here that injury severe enough to fracture a transverse process or the body of a vertebra will injure the cord also in all probability. Theoretically, if a fracture occurs here the parts are so splinted anatomically that recovery without increase of deformity is to be expected, unless a subsequent infection occurs, with caries or necrosis.

By far the larger number of cases I am discussing to-day are found in the dorso-lumbar region. The thorax acts as a long lever most powerfully on the first weak point, therefore the eleventh and twelfth dorsal and first lumbar are especially liable to be injured when the body is bent strongly forward, as occurs so frequently in falls.

The following cases occurred in my private practice and caused me considerable uneasiness from time to time.

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J. E., aged forty-two years. Good family and personal history. Fell from roof twenty-five feet, striking on feet, then bending forward. On admission to a hospital he was frequently examined, and assured that his spine was not injured. He complained of a good deal of pain in the left gluteal region, and this continued for three to four weeks. His spine was examined repeatedly for the next three weeks, but nothing was discovered to account for the weakness he felt in his back, which was so pronounced that he could not hold himself erect, either sitting or standing, without support. There was slight tenderness over dorsal and lumbar spine. A month after the accident I found a very slight kyphosis at twelfth dorsal and first and second lumbar. A spinal assist was applied. The cure was perfected in four months, though the patient was an adult. There could not have been any tubercular infection in this case.

G. D., a man, aged twenty years, over six feet tall, and weighing over 200 pounds, slipped while carrying a weight, and was thrown backward. He felt something give way in the lumbar region. He felt the sensation of "pins and needles" in his feet for a short time, but soon went to work on his farm as usual. Two months later he injured the same place, and again seven months later; this time he was in bed ten days. A fourth and fifth similar injury soon made his back so painful that he had to stay in bed.

September, 1889, I first saw him, and found a very slight kyphosis at ninth and tenth dorsal with some tenderness, and a slight lordosis of twelfth dorsal and first lumbar vertebræ. The knee-jerks were exaggerated. Pain on motion, and some paræsthesia and muscular twitchings of legs. Could walk only one or two steps. January, 1890, four months later, I saw him again at St. Luke's Hospital, and put him to bed wearing a plaster-of-Paris jacket. July, 1893, three-and-a-half years later, he could walk half a mile; reflexes normal; no deformity found; no pain; tired readily; final brace applied. February, 1895, one-and-a-half years later, walks three miles, does farm work, with crowbar and the like. Splendid general health, fat and rosy. Cured.

Notwithstanding the long duration of the local symptoms, I do not believe that this man had Pott's disease, because (1) of his good

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family and personal history; (2) his splendid physique; (3) the absolute carelessness of his conduct which prevented his ever giving long-continued rest to the injured spine; (4) local condition. At the present time there is no deformity except a slight depression at the first lumbar spine. Motions of the spine are almost perfect. He has no pain and no disability.

Mr. C., good family history, also good personal history. When fourteen years old had a severe fall on back in a gymnasium. He was laid up for two or three days, and his back was very sore for a long time. And in the following years, though he rowed, drove, etc., three or four times each year, he would have severe pains in the dorsal and lumbar regions for a week or so, then they would gradually die away. When he was eighteen years old he noted a swelling in right lumbar region which became large and tender, and he had chills. The abscess contained pus and blood. Three months after this was opened a spiculum of bone was discharged. There was no spinal deformity at this time. After two months he was taken to St. Luke's Hospital, where a small kyphosis was noted, and I applied a "spinal-assistant" brace. The abscess continued to discharge for three years, when a large sequestrum was discharged and the abscess promptly closed. The pain was always in the back, not anteriorly, but was at once relieved by the brace, which he wore six years, though he was believed cured two years before he discarded it. Examination February 16, 1898, six years after brace was removed, shows eleventh dorsal slightly prominent only because twelfth dorsal and first lumbar are a little depressed. Anterior, posterior, and lateral motions about normal. Fat and well; weighs 175 pounds and has a chest expansion of five inches. I do not consider this case tubercular, nor does Dr. Shaffer, who also saw the patient several times with me. Mr. C. was, however, refused insurance by the Mutual Life Insurance Company within the past four years, because there was a rule against taking risks on persons with Pott's disease. This was done, though the medical inspector highly recommended the risk. He was also refused by the Provident Savings Life Insurance Company for the same reason within the last eighteen months. The Equitable, however, were willing to take the risk to any amount.

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I have the histories of about a dozen other similar cases, but I will not detail them, but will say that a number of them were in the large general hospitals for days and weeks even without a correct diagnosis having been made. This may be accounted for often from the fact that the deformity will frequently not appear until the patient assumes the upright position.

The lumbo-sacral juncture is another part of the spine which is especially liable to injury.

I have notes on two cases of spondylisthesis which had at some time been mistaken for Pott's disease; I will very briefly cite them on this account as well as to show the good effect of treatment.

Mrs. de C., seen with Dr. P. H. Fitzhugh, aged thirty years, fell heavily when two years old, injuring fifth lumbar vertebra. At eight years another severe fall, necessitating seven months in bed. Never well since. Wore imperfect supports for a time. A third fall a year ago, and was in bed two weeks at that time. Has been married twelve years and had two stillbirths, with great increase of spinal pain and increase of curvature after the last one, eighteen months ago. Examination shows well-marked deformities of spondylisthesis. Can walk but a few steps. Cannot sit up, and has pain even when supine. Has a great deal of pain in abdomen and legs and back. A spinal brace with abdominal belt was advised to give rest to the spine and to relieve the lordosis. The result was immediate relief, and within a few months she could walk miles, sit throughout an entire performance at the theatre, etc., which she had never before been able to do.

M. T., aged twenty-six years, fell on some stones when six years old, striking back; never perfectly well again. At sixteen years could hardly walk at all on account of weariness in legs and tired feeling in back. Then was in hospital two years, gradually improving with quiet life. Now, after two years of heavier work than she has been accustomed to, she presents herself for treatment on account of a marked tired feeling in her back. She can walk two miles, and can stand jars, but cannot stoop forward. Marked lordosis. Pubes prominent and pelvis tilted upward. Spondylisthesis. Spinal uprights applied February 11, 1891, with marked relief to the tired feeling.

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The explanation I would offer for these cases of traumatism of the spine simulating Pott's disease is as follows: A fracture in a long bone will require from six to eight weeks to become consolidated. Where the vertebræ are fractured and little or no injury is done to the cord, there are local weakness and some tenderness, but often only a moderate amount of pain—that is, comparing it with that accompanying fractures of the long bones—and often no crepitus, so that the injury to the bone may escape notice. As a rule, therefore, a sufficiently long period of rest and protection is not enforced. Moreover, it is very difficult to keep these parts quiet on account of the small size of the bones themselves and the length of the body above and below the injured part. Probably non-union results. There may be no deformity at first, on account of the many powerful ligaments and muscles holding the parts in place, but when the erect position is assumed the weight of the body will *gradually* produce a kyphosis or lordosis as the case may be. Aside from the history of the accident, the picture now presented is one of ordinary chronic osteitis and might easily be mistaken for Pott's disease. We have the characteristic deformity, the reflex spasm, and continuing pain and disability.

I cannot believe that tuberculosis occurs in the osseous system primarily. At the New York Foundling Hospital I made many autopsies, when I was an interne there, on cases in which this looked possible, but always found enlarged bronchial or mesenteric glands also, showing the path by which the bacilli gained entrance to the system.

I do not think, either, that the presence of abscess and extrusion of bone prove an inflammation to be tubercular. I have seen several cases in which a severe traumatism of the spine was followed, within a short time, by abscess-formation which did not appear tuberculous, both in the cervical and dorso-lumbar region.

A consideration of the cases I have studied (7 cervical, 14 dorso-lumbar, and 2 lumbo-sacral) seems to show that there are cases of traumatism simulating Pott's disease. The importance of this from a medico-legal stand-point is at once apparent without discussion. The mental complexion of the patient and his family would be entirely changed in the two cases. Then, again, life insurance should not be refused such cases. Some of the companies have hard and

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fixed rules, such as the one referred to, that no risks should be taken on a person with Pott's disease. Where a mistaken diagnosis can so readily be made which would work to the applicants' disadvantage, it would seem more just to consider each case separately.

And lastly, I would strongly advise protection of a suspected spine after severe falls or twists for a sufficiently long time to insure union in case fracture has occurred, remembering that deformity will often first appear only after the erect position has been assumed.

DISCUSSION.

DR. A. B. JUDSON, of New York, said that a good service had been done in calling attention to the important element of time in these cases. It would be recalled that in a great many orthopedic cases time is a very important feature. For instance, most of our patients are children, and in the treatment reliance is placed largely upon the benefit to be derived from the child's growth when properly treated. The cases just presented in the paper emphasize the importance of time as an element in making the prognosis. In an allied subject some time ago, Dr. Myers had made the remark that if a doubtful case were cured in a reasonable time the diagnosis of tubercular disease should be reconsidered. In a case of Pott's disease which is liable to extend over a number of years in the treatment, it seemed clear, also, that a choice should be given to an apparatus constructed of steel; whereas, in a case in which the symptoms are more sudden and acute, and the treatment is likely to extend only over a period of a few months, or a year or two, preference might well be given to a plaster-of-Paris apparatus.

DR. REGINALD H. SAYRE, of New York, said that he had been much interested in the paper, for he had encountered a number of similar cases. He had had some patients recover very promptly apparently after traumatisms of the neck. He had in mind three, in which the symptoms lasted for a number of years, yet on two or three different occasions they seemed to be entirely well, the motions

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of the neck being apparently normal, and all pain and disability having ceased. But on the removal of support the disability soon returned, necessitating the reapplication of the apparatus. One of these children had been injured by diving over a rope, striking on the neck and bending it sharply. Another child was struck across the neck by a beam. Both cases had seemed to be well, but the symptoms had returned on the removal of the apparatus. He did not feel like agreeing with the reader of the paper, that all cases of bone injury which recover in a reasonable time are non-tubercular any more than he would be willing to say that all cases of inflammation of the lung that recover in a reasonable time are non-tubercular. It was well known that cases of inflammation of the lung, with cough, expectoration, and tubercle bacilli in the expectoration, do occasionally, under favorable conditions, cease to progress, and the symptoms greatly improve. At autopsies one frequently finds evidence of old tubercular processes which have been recovered from spontaneously and without having given rise to symptoms sufficiently definite to lead to the suspicion of tuberculosis. It was known that dogs which had had their joints violently sprained and then injected with tubercular germs were prone to get up inflammation in those joints rather than in other parts of the body. It did not seem to him at all incompatible with our present knowledge of the etiology of tuberculosis to suppose that tubercular osteitis, if promptly and efficiently protected, might recover in a reasonably short time instead of pursuing a course extending over four or five years. When the patient's health is sufficiently good and the protection adequate, it seemed to him that these cases might recover in that way. The question of prognosis was one which could not be answered definitely, with our present knowledge. A disease of the spine coming on after pronounced traumatism ought, on general principles, to get well much more promptly than one which comes on insidiously and without any definite history of injury. Further than this he did not think one could say at present.

Dr. Myers said that he had attempted to call attention to the fact that there were cases of traumatism of the spine associated with more or less kyphosis, whose subsequent history was so short and uneventful and the results so good, that it seemed to him that tuber-

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culosis could be eliminated. He had wished to get some expression of opinion regarding the shortest length of time that a tubercular lesion in the spine would require for cure, and also the longest time that a simple inflammatory process might exist without being considered as due to tubercular infection. He thought the medico-legal and insurance aspects of these cases were important.

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HALLUX VALGUS EXTREMUS.

By A. J. STEELE, M.D.,
ST. LOUIS.

The drawing (Fig. 1) shows a male adult foot with the most pronounced case of hallux valgus it has been my lot to see. When the case first presented itself, now about eight months since, the toe was abducted to a right angle to the first metatarsal and overrode the other toes, or rather lay in the gutter formed by the four outer toes and their corresponding metatarsals. A bunion with hypertrophy of the underlying bone caused marked prominence of the

Fig. 1.

Fig. 2.

ball of the toe. The phalangeal base was so displaced as to articulate with the outer side of the head of the metatarsal, which was thus, in part, left uncovered. Locomotion was labored and at times painful, the gait peculiar and wanting in elasticity.

Some months previous, either from neglect of treatment or from improper treatment of the bunion, inflammation extended through-

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out the foot—probably a cellulitis, involving the ankle, and confining the patient to bed for several weeks. This left the parts more or less stiff from adhesions. The extensor tendon of the big toe was pronounced and tense, and, being displaced outward, tended to increase the abduction.

Fig. 2 shows the result of an operation done for the relief of the deformity. The metatarso-phalangeal joint was exposed by a longitudinal incision over its inner and upper aspect, and the base of the proximal phalanx divided with the bone forceps and removed. After division of the extensor tendon the toe was readily brought into line and put in a plaster-of-Paris dressing. The straightening of the digit caused the redundant tissue on the inner side to fold in on itself, forming a marked sulcus, which gave rise to some little apprehension; this, however, was groundless, as in time absorption and shrinkage of the superfluous tissue gave the parts a normal appearance.

A fibrous union occurred between the two bones, affording sufficient motion for practical use, though the ankle- and foot-motions were somewhat limited, owing to the tissue thickening and adhesions from a former cellulitis.

In the method of operation adopted I disregarded the advice usually given for the relief of this deformity, which is to remove the head of the metatarsal bone, for it seemed to me that in such procedure the sustaining and propulsive power of the foot would be impaired. The head of the first metatarsal bone is one point of the foot-tripod upon which the body-weight is borne, and with its removal or impairment functional disability results. Far better to preserve that point and find other means to straighten the toe, which I think we can best do by operation on the base of the proximal phalanx. While not interfering with the bony structure of the metatarsal, yet it is well to shave off the cartilage, that more prompt and close fibrous union may take place.

The cause of the deviated toe in the case related was, I believe, wearing of short boots, for even as he first came to me with his incapacitating deformity the boots worn were very short.

Dr. Steele also exhibited a moccasin worn by the Sioux Indians, as showing the proper shape of a shoe which would not restrict or

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deform the foot. The inner side of the moccasin was a straight line from the heel to the point of the big toe.

DISCUSSION.

Dr. F. S. Coolidge, of Chicago, said that he had had a few cases of bunion with hallux valgus. Once after excision of the head of the metatarsal, and in two cases in which part of the head of the metatarsal had been left, instead of recovery occurring at the end of three or four weeks, there was lasting pain for four or five months. There was positively no infection in these cases. It seemed to him that by elevating the head there might result an inflammation of the joint-surface. In all of the cases the proximal end of the phalanx was left.

Dr. J. E. Goldthwait, of Boston, said that in the more severe cases requiring operation he had removed the head of the metatarsal bone. He had never observed any unpleasant after-features from such treatment. None of the patients had been kept off the feet for more than four weeks; usually they began to walk at the end of two weeks.

Dr. Ansel G. Cook, of Hartford, said that he had operated upon three cases similar to the one presented. In all of them he had been consulted because of an inflamed condition and a sinus. In all three the head of the metatarsal bone had been extensively diseased, so that it would have been folly to leave it. The phalanx was, however, normal. He had, therefore, contented himself by cutting off the head of the bone and part of the neck, leaving nothing but healthy bone. One of them, a very old gentleman, recovered in two weeks; a second patient recovered in four weeks, and the third, although recovering more slowly, also did well. It was rather curious, considering the extent of the disease in the head of the bone, that the phalanx in these cases was not involved. After operation the toe came into straight position, but was telescoped backward.

Dr. W. R. Townsend, of New York, said that there had been a number of articles published recently on this subject, and most of

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the writers agreed upon the necessity of operative procedure. It was particularly insisted that the scar should be in such a position as not to be pressed upon by the boot. Theoretically scars should not be tender, but practically they are so in many instances, and faulty boots will often cause discomfort after operation, even though the scar shall have been placed in proper position.

DR. R. H. SAYRE said that he had always operated by removing a portion of the bone, sometimes by an incision between the two toes, as advocated by Fowler, and sometimes by the outer incision. Recently he had seen skiagraphs of several bad bunions, and they had led him to doubt the propriety of operating by the method hitherto employed. In cases in which the bone is not so extensively diseased as described by Dr. Cook, the bone had been removed on the supposition that there had been an overgrowth of the head of the metatarsal, but the skiagraphs referred to showed that this was not the case; they showed dislocation of the phalanx and great separation of the first and second metatarsal bones, with stretching of the transverse ligament, the phalanx lying almost at a right angle to the metatarsal bone. It seemed to him that division of the metatarsophalangeal ligament in these cases would probably answer the same purpose as the removal of the head of the bone. In the cases upon which he had operated the bone had not appeared to be as large as he had expected to find it. The skiagraphs showed very plainly that the undue prominence was due rather to a change of position of the phalanx than to hypertrophy of the distal extremity.

DR. GOLDTHWAIT said that he had done a number of conservative operations along the line suggested by the last speaker, and while the results had been fairly good as regards the position of the toe, the period of convalescence had been very much longer and the ultimate result, as regards the motion of the joint, very much less satisfactory. The shortest period of convalescence in this series of cases had been six weeks. The treatment by excision gives a much more perfect foot as the ultimate result.

DR. STEELE, in closing the discussion, said it is true, as Dr. Sayre has suggested, that there is not usually hypertrophy of the head

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of the metatarsal bone; certainly not enough to require operation on that account. As regards the choice of operation, if the head of the metatarsal bone could be removed and good locomotion still be maintained, this was a proper manœuvre; but his contention had been that as this was one of the points of the tripod upon which the foot rests in sustaining the body weight, it was not wise to remove it, but rather the base of the phalanx, which would give equally as good a result in the removal of the deformity and without impairment of function.

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THE BOOT AS AN ORTHOPEDIC APPLIANCE.

By H. P. H. GALLOWAY, M.D.,
TORONTO, CANADA.

Here and there in orthopedic literature are to be found references to the necessity of using boots of suitable shape and modified construction in the prevention and treatment of certain conditions of disability and deformity. It may be doubted, however, whether the subject of boot construction has received as much attention as its importance deserves, and whether the power of variously-modified boots to serve some of the purposes of orthopedic practice is as fully appreciated as it ought to be. In my own practice I find certain forms of boots quite as indispensable as any other kind of appliance. A large proportion of patients who present themselves are in need of advice concerning the clothing of their feet, although they are not always aware of the fact; and were I deprived of the advantage to be gained by the use of some of the boots shortly to be described I should often feel sorely perplexed. At the outset, however, I desire to disclaim any expectation of saying anything startlingly new or original. I hope, rather, to excite fresh interest in an old subject; to show some patterns of boots that may differ somewhat from those ordinarily employed; to point out certain defects in construction, and to direct attention to the possible advantage of a more extended employment of the boot as an orthopedic appliance.

In nearly all works on orthopedic surgery, in connection with the treatment of flat-foot, it is recommended that the inner side of the sole and heel of the boot worn by the patient be built up higher than the outer side. We are indebted to the late Hugh Owen Thomas, of Liverpool, for this valuable suggestion. His plan, which is that ordinarily followed, was not only to raise the inner border of the sole and heel, but, at the same time, to fill up the space beneath the

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shank, which corresponds to the arch of the foot, to the same level. In doing this it is important so to build the boot as not only to make the sole thicker at the inside, but, at the same time, to project it inward. By this means a broader foundation is placed under the patient, and we gain support and leverage, so acting as to raise the inner border of the foot and assist in overcoming that pronated position which is now recognized as often more concerned in the production of the symptoms of flat-foot than mere flattening of the arch.

In dispensary practice, and for patients who are regardless of appearances, provided they obtain relief, this modification, applied to the Waukenphast or other common-sense boot, answers tolerably well; but in private practice we meet with many cases of weak feet in patients, especially young women, who cannot be persuaded to wear anything that departs so far from the conventional. All orthopedic surgeons are aware of the necessity of carefully inspecting the feet as an important part of the routine of examination in cases of scoliosis. In my experience this inspection reveals a pair of weak, pronated feet in the majority of cases; and although symptoms pertaining to the feet may not be complained of, I feel that it is next to hopeless to begin treating the deformed spine without first putting the patient upon a more secure foundation. In many cases the condition of the feet is obviously due, in part at least, to the fashionable boots, with narrow soles and high heels, which the patient has just removed to permit of her feet being examined; and to attempt to treat by developmental methods a case of scoliosis or of flat-foot while the patient is perched upon a pair of boots which afford no security, and make it impossible for the feet to be used to the best mechanical advantage, is indeed a discouraging task. But while many patients, especially ladies of the better class, cannot be persuaded to wear boots as clumsy looking as the ordinary pattern of flat-foot boot, the benefit of the raised and projected inner border can be secured by the modification of the ordinary plan of construction shown in Figs. 1 and 2. In general, the last upon which this boot is built differs from an ordinary last chiefly in having a straighter inner border, in greater width, and especially in having a very broad and flat sole. The heel of the boot is much lower and larger than usual, and its inner side

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widens out laterally as it approaches the floor, while its inner border is not only built up higher than the outer, but is continued farther forward beneath the shank; the inner side of the sole just beyond

FIG. 1.

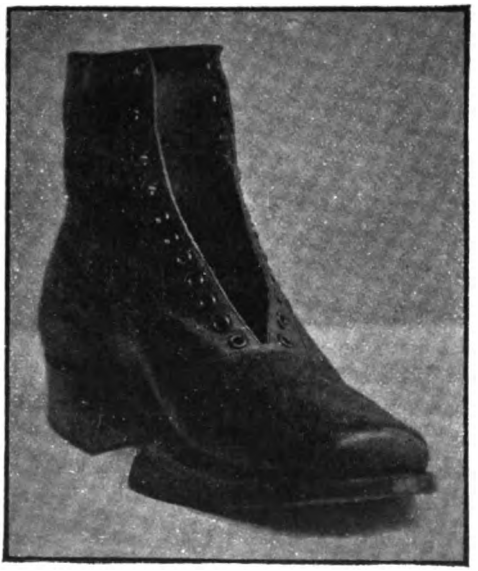
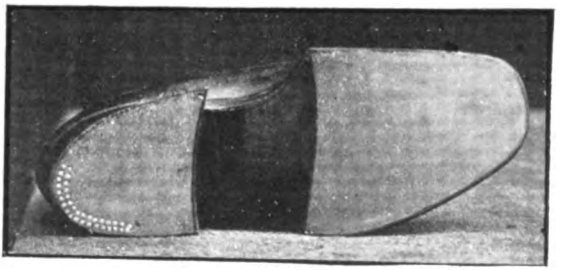


FIG. 2.



the shank is correspondingly raised and projected inward. By this plan of construction the same mechanical effect is secured as if the whole inner side of the sole, shank, and heel were a solid mass of leather, as in the ordinary form of flat-foot boot, while, at the same

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time, the boot is not only lighter than it could be if the arch were filled up with leather, but the departure from the conventional appearance is relatively so slight that it is very exceptional to meet with patients of any class who refuse to wear it. On the inside of the boot there is a strong counter of leather, of about the same size and shape and occupying the same position in relation to the foot as the inner flange of a Whitman flat-foot brace. It gives some support to the foot at its weakest part, and, which is still more important, by exerting pressure in this situation it serves to remind the patient of the necessity of holding up the inner side of the foot by muscular effort. As Dr. Whitman himself teaches, this function of the brace devised by him is a much more important one than is its action as a pure mechanical support. Of course, being made of yielding leather, instead of unyielding metal, this counter is not expected to serve as a substitute for Whitman's brace in cases of a severe grade; but many of the slighter cases of flat-foot can be successfully managed by suitable exercises, training in the use of the feet to the best mechanical advantage, and the wearing of suitable boots. In these cases the addition of the leather brace I have described is of considerable value.

The mechanical principle involved in the construction of the flat-foot boot may with great advantage be applied in the making of boots to be used with or without braces in cases of valgus resulting from infantile paralysis. Very frequently the paralyzed limb is considerably shorter than its fellow, and in such cases the first point in mechanical treatment should be the providing of a suitable boot, with a sufficient amount of cork to make up the deficiency in length; but instead of making the upper and lower surfaces of the cork parallel, and its sides perpendicular and symmetrical, as is usually done, it should grow gradually thicker toward the inner side, so as to be from one-fourth to one-third of an inch higher than at its outer margin. Its inner side should also slant decidedly from above downward and inward. (Fig. 3.) A boot so constructed answers most admirably in many of the slighter cases of valgus resulting from infantile paralysis, and will often prove to be the only thing of the nature of a mechanical appliance required. It should be a principle in orthopedic practice never to use braces of any kind if it is possible to get along as well without them; but

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when the interest of the patient demands the employment of a mechanical appliance it should always be the simplest that will answer the purpose. More or less pressure and constriction are inseparable from the use of most forms of orthopedic apparatus; this constitutes a serious objection, because it means interference with the nutrition and development of tissues which are frequently

FIG. 3.

already atrophied and weak; and although this disadvantage may be unavoidable, we should seek to reduce it to a minimum. In the class of cases under consideration, should any of the appliances usually employed to hold the foot in its proper relation to the leg be necessary, they can as easily be attached to the cork boot just described as to one of ordinary construction, and the efficiency of the brace will by this means be greatly increased.

We will now turn our attention to a couple of boots, in the construction of which the mechanical principle involved is exactly opposite to that of the flat-foot boot. The first is a club-foot (equino-varus) boot. It is not, however, designed to correct the deformity, but to assist in

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preventing relapse after the foot has been fully corrected or over-corrected by operative means. The last is of such shape that the front part of the boot is bent outward at a point corresponding to the medio-tarsal joint. The heel counter is very firm, and an additional brace of stiff leather at a point corresponding to the first metatarso-phalangeal articulation affords a point of counter-pressure and serves to keep the foot from assuming the varus position, while the rolling downward and inward of the outer border of the foot is counteracted by having the outer side of the sole well built up and projected a considerable distance beyond the upper. (Fig. 4.) By

FIG. 4.

this construction considerable leverage is gained, and every step of the patient forces the foot in a direction opposite to that which it is disposed to assume. This boot, the invention of Dr. B. E. McKenzie, is a simple and valuable adjunct in the successful after-management of club-foot. Also, in the treatment of cases of paralytic club-foot it will be found very useful; and should a high sole be desirable on account of shortening, the plan of constructing the cork with its outer side projected and elevated should be adopted. The boot so built will supply all that is necessary in the way of apparatus in many cases, while if a brace be required it will serve much better if attached to a boot of this form than to one without

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such modification. These modified boots will, however, fail to accomplish their purpose unless the shoemaker succeeds in so building the sole that it will touch the floor in its entire breadth when the whole surface of the heel is in contact with the floor. It is useless to project the sole and build it thicker on one side than the other if it is made so convex that all the weight comes upon a small area at about its middle. Shoemakers invariably fail to grasp this point, and even in repairing they seldom succeed in restoring the original form until they have been specially trained. Just here I wish to say a few words about the construction of ordinary cork-soled boots; I mean those which are intended simply to supply a deficiency in the length of the limb upon which they are worn. Pattens of some kind are constantly needed in orthopedic practice, and those made of cork are perhaps as free from objection as any other; and while the shoemakers have acquired some success in devising models of high-soled boots which are, as far as possible, unobjectionable in appearance, many of these serve the purpose for which they were intended very inadequately. There are five chief faults with the ordinary cork-soled boot:

1. The shape does not correspond to the shape of the foot.
2. The sole is too narrow.
3. The sole is convex from side to side.
4. The heel is too small.
5. The shank is weak and unsupported.

Of these faults, perhaps the most serious are the narrow and convex sole and small heel. In my office I have often taken one of these boots, which a mother had just removed from her child, and placing it upon my desk have with a slight touch set it rocking from side to side like a cradle, and have pointed out that the sole of the boot in front of the shank resembled a portion of the surface of a globe, only a very small area coming into contact with the floor; while the high, slender heel, with its sharp margins worn off, formed a mere prop under the back part of the foot. Watch a patient standing in such a boot, and you will easily observe that in effect he is poised on the rounded lower ends of two small columns. Such a condition of affairs would be bad enough with the locomotor apparatus of the patient in every way normal; but the very fact that a patten is necessary is proof that there is some defect in this

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apparatus; consequently there is increased reason for so constructing the high boot that it will form a secure and reliable foundation for the limb upon which it is worn. Should such a boot be necessary because of some antecedent disease which has left one limb shorter than its fellow, how is the short limb to do its full share of work if, already more or less disabled, it has to suffer the additional disadvantages imposed by a boot which is liable to roll and wabble at each step of the patient? Or, if worn upon the sound limb, with

FIG. 5.

the object of elevating it to a sufficient height to prevent its disabled fellow from coming into contact with the floor, it is still more necessary that it should afford reliable support with no disposition to sway unsteadily; for in this case the patient bears all his weight either upon the sound limb alone or upon a splint and the sound limb, and a splint is by no means equal as a support to a healthy leg and foot. Hence, in constructing a cork-soled boot, particular attention must be paid to having the sole broad and flat, so that its entire

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width shall come into contact with the floor; the heel also must be large and perfectly flat. From its upper surface, where it is attached to the upper of the boot, the cork should grow wider as it descends to the sole, thus giving it increased breadth of base and making the patient more secure, on the principle that a stool with diverging legs is less liable to topple over than one with legs which are perpendicular. (Fig. 5.)

If the height of the patten required is an inch or less it is possible to construct the boot satisfactorily by adding the necessary amount of cork to that part of the sole in front of the shank, and increasing the height of the heel to a corresponding extent. The appearance of the boot so constructed is preferred by some patients, especially ladies. A thin cork elevation may even be put wholly inside the boot. But if more than an inch of added height is required it is decidedly preferable to have the cork extend over the whole area of the sole, and to build upon the cork a low, broad, flat heel of leather. To put from one to four inches of cork upon the front of the boot, and on the back part a heel of corresponding height, with an unsupported shank between them, is a bad mechanical arrangement, and, in the writer's opinion, can hardly be defended, even from cosmetic considerations. A boot with a solid foundation under it of from one to three or more inches in height may be objectionable because of its heavy and bulky appearance, but scarcely less so is one in which the shank is cut away so as to leave a high, narrow heel, which looks like a mere prop under the back part of the boot, while the latter has the additional disadvantage of affording an unreliable and shifting foundation; for in a boot of this design the unsupported shank yields more or less and forms a kind of hinge between the elevated sole and heel. A judicious compromise between these two plans of construction, which is perhaps free from the objections attaching to both, is to cut away part of the cork beneath the shank, enough to form a respectable arch, without entirely divorcing the raised sole from the high heel; so built, the shank will still be sufficiently rigid, while the heel will not have the appearance of a prop.

The boots before described are for use only after conditions of deformity or disability have set in. But as at least one of the pathological conditions above referred to as requiring in its treatment a boot of special construction—namely, flat-foot—is largely

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caused by injury to the structure and function of the foot inflicted by the badly-designed boots that are commonly worn, the consideration of prophylaxis arises, and it becomes a pertinent question: "What are the characteristics of a good boot for ordinary wear with the foot in a condition of health?" Dr. Lovett thus summarizes the answer in vol. ii. p. 662, of Roswell Park's *Surgery:*

"The essentials of a good boot are as follows:

"The inside line should be straight or nearly straight.

"The boot should be built to hold the foot in an adducted position; that is to say, the forward part should be at an angle to the hind part if their axes are shown by lines drawn in the middle of the sole and middle of the heel.

"There should be plenty of width across the metatarso-phalangeal joints, in order that the weight may be properly borne upon the ends of the metatarsals, and the sole of the boot should be as wide as the sole of the foot.

"The shank should be broad, not cut away, at its inner aspect; it should be fairly stiff."

To this I would add: The sole should be flat, not convex, from side to side, and only slightly turned up at the toes. The heel should be low, flat, and large, not only broad but long, for a stiff shank will be of little service unless sufficiently supported by a good heel below. A small heel soon becomes rounded at the edges and allows the foot to roll, twisting and weakening the shank of the boot and rendering the foot liable to strain.

Although boots with the front part strongly adducted in relation to the back part, and with a straight inner border, are beyond doubt theoretically correct, in practice I have not found them as easily employed as I anticipated. A couple of years ago I had a set of lasts manufactured after the model of the one shown in Fig. 6. The model was based on plaster casts of the least distorted feet I could find. Whatever other defects this last may have, it at least fulfils the requirements of a straight inner border and an adducted forepart. But it is only very exceptionally that I can recommend my adult patients to have boots made from this last, unless I intend to have a toe-post built into the boot to keep the displaced great toe in proper position. The feet of practically all adults in civilized life have the great toe deflected outward, and if the boot is made

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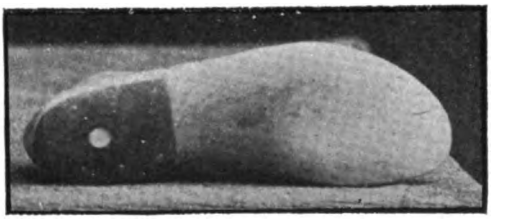
with its inner border straight the result is an unoccupied space to the inner side of the great toe, unless some device such as the toe-post is employed. Also, the greatly adducted forepart of the boot has, in my experience, been apt to cause uncomfortable pressure upon the smaller toes, cramping them under the foot and causing corns; but this is, doubtless, due more to deformity of the foot than

FIG. 6.



to the shape of the boot, as the normal adduction of the foot at the medio-tarsal joint, as seen in the infant, is apt to have largely disappeared, or even to have given place to abduction, by the time adult life is reached. If, however, a form of boot meeting the requirements summarized by Dr. Lovett were worn continuously from infancy, I fancy that perfectly normal feet in the adult would cease to be such a rarity as at present. It should be said, however, that it is useless to construct a boot of proper shape unless some attention is at the same time bestowed upon the stockings. These are nearly all made with pointed toes, and constitute a mechanical force sufficiently powerful, acting, as it does, every day in the year, to deform the foot even without the assistance of badly-shaped boots. Socks and stockings should always be made with a separate compartment for the great toe.

I wish to add a word as to the manufacture of the special forms of boots to which reference has been made in this paper. The experience of Dr. B. E. McKenzie and myself has been that the only sure way of having our wishes executed is to train our own mechanics and have the work done in our own shops. Even then it is necessary to keep a watchful supervision of the work to prevent slight departures from original models, and to guard against the introduction of unauthorized "improvements" by the workmen. To

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send a patient to the shoemaker with instructions to get a particular kind of boot is to court certain disappointment. The patient will almost surely suggest slight modifications, with a view of improving the appearance, etc., and these wishes are obligingly met, as far as possible; and if the patient is pleased with the result the shoemaker will gradually introduce more and more of his own conception of what is required, until in a few months he is turning out boots which bear little resemblance to the original pattern. We have found that even in making repairs an untrained mechanic will, almost without exception, show that he has little or no conception of the mechanical requirements of the special boots here described; and after the repair is completed the surgeon may congratulate himself if the restored boot is even a near approach to the original. If the surgeon desires to get the best results obtainable from the use of modified boots in the management of orthopedic conditions, it is absolutely necessary that he should to some extent personally supervise the work of the mechanics who make them.

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OBSERVATIONS ON MORTON'S PAINFUL AFFECTION OF THE FOURTH METATARSO-PHALANGEAL ARTICULATION AND SIMILAR AFFECTIONS OF THE METATARSAL REGION THAT MAY BE INCLUDED WITH IT UNDER THE TERM ANTERIOR METATARSALGIA.

By ROYAL WHITMAN, M.D.,
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In 1876 Dr. T. G. Morton, of Philadelphia,[1] described a series of cases characterized by recurrent pain about the fourth metatarso-phalangeal articulation. The pain was usually sharp and cramp-like in character. It was at first localized at the affected joint, but unless it was checked it increased in intensity and extended to the other toes, to the dorsum of the foot, and to the leg. The cramp might be relieved in most instances by removing the shoe and by rubbing and compressing the painful part.

The pain was ascribed to pinching of the external plantar nerve or its interosseous fibres by the adjoining fourth and fifth metatarsal bones. The location of the pain was explained by the peculiar distribution of the external plantar nerve, which predisposed it to injury; by the relative shortness and mobility of the fifth metatarsal bone, which allowed it to roll above and under the fourth, the head and the base of its adjoining phalanx being thus brought into contact with the head and neck of its fellow. As a result of the bruising or pinching, neuritis followed.

The original cause of the abnormal mobility, or of the condition that allowed the pressure, in many instances was injury, possibly rupture of the transverse ligament; in other cases the pain appeared

[1] American Journal of the Medical Sciences, 1876.

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to be caused by tight shoes; in others no cause could be assigned. The description of the symptoms was graphically sketched in the words of the patients themselves, and no amendment is needed, except that the cases described were of a more severe and disabling character than is usually seen at the present time.

The treatment recommended and applied in a number of the cases was the removal of the head of the fourth metatarsal bone, in order to relieve the nerve from pressure, an operation that was successful in all the cases in which it was employed. In a later paper[1] Morton stated that the affection was familiar to shoemakers, and that the milder cases might be relieved by wide, thick-soled shoes, and by the use of a narrow flannel bandage drawn snugly about the metatarsal region.

In 1891 Bradford, of Boston, described sixteen cases of Morton's neuralgia of a milder type.[2] Bradford accepted Morton's theory absolutely, or, as he stated, "took it for granted that the pain was entirely due to an irritated condition of the external plantar nerve, caused by pressure." Yet in none of the cases was he obliged to perform resection, in none was the affection due to injury, and in none was flat-foot present. In all but one of the cases the pain was at the fourth metatarso-phalangeal articulation. The cases were treated by rest, by external applications, and by wide-soled shoes, and all appeared to have been relieved or cured.

Two years later T. S. K. Morton,[3] of Philadelphia, reported six cases of the severe type, all of which had been treated by resection of the head of the metatarsal bone. He stated that he had not been able to demonstrate any laxity of the transverse ligament or other abnormal condition at the operation. He believed the etiological factors to be injury, heredity, excessive exercise, changing from a thick to a thin-soled shoe, and the like. The immediate cause of the symptoms was bruising of nerves, followed by neuritis. As remedial measures wide, thick-soled shoes, sufficiently firm about the instep, together with the support of the flannel bandage about the metatarsus, might relieve the milder type, but advanced cases could be cured only by resection. In 1894 Gibney[4] reported six cases.

[1] Philadelphia Medical Times, October 2, 1886.
[2] Boston Medical and Surgical Journal, vol. cxxv. No. 3, p. 52.
[3] The Annals of Surgery, 1893, vol. xvii. p. 680.
[4] American Journal of Nervous and Mental Disease, September, 1894.

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He accepted Morton's explanation of its causation, but included flat-foot in the etiology. He made a valuable suggestion that the arch of the foot should be supported by a high-arched shoe made on a Spanish last; he also had relieved patients by encircling the base of the metatarsus with adhesive plaster, on the hypothesis that the heads of the metatarsal bones were thus separated.

In a recent paper by T. G. Morton,[1] illustrated by several Roentgen-ray photographs, three other cases treated by excision are reported. He states that "twenty years after his first description of the affection he finds no reason to change his original opinion that it is a painful affection of the plantar nerves, directly caused by pressure upon them or pinching them or their branches by certain portions of the fourth or fifth metatarso-phalangeal articulations."

In 1889 A. Poullosson, of Lyons, described under the title of "Anterior Metatarsalgia," a case apparently identical in symptoms with those described by Morton and others. He ascribed the symptoms to laxity of the transverse metatarsal ligament that allowed an infraction of the metatarsal arch by the depression of the head of the fourth metatarsal bone, a subluxation that permitted lateral pressure upon the nerves distributed on either side of the bone. On this theory he had treated the patient successfully by inserting a rubber pad beneath the depressed bone. Poullosson's case was reviewed at length in the *Lancet*,[2] and the article apparently attracted considerable attention.

Roughton, in a letter to the *Lancet*,[3] reported a similar case, and asserted that the symptoms "were clearly due to sinking of the anterior transverse arch and to the resulting pressure of the heads of the two or three middle metatarsal bones upon the sensitive structures of the sole of the foot.

Another writer in the same issue describes a case in which relief of symptoms always followed the pushing up of the head of a depressed metatarsal bone that could be felt in the sole of the foot.

In 1892 T. L. Guthrie[4] reported a case of anterior metatarsalgia, caused by depression of the head of the third metatarsal bone, which he had treated by a pad placed beneath it.

[1] International Medical Magazine, 1896 and 1897, vol. v. p. 322.
[2] March 2, 1889, p. 436.
[3] March 16, 1889, p. 553.
[4] Lancet, March 19, 1892, p. 628.

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C. E. Woodruff,[1] in a paper on "Incomplete Luxations of the Metatarsal-phalangeal Articulations," stated that anterior metatarsalgia was caused by giving way of the anterior transverse arch, owing to stretching of the transverse ligaments by long standing, injury, and the like. The disturbance of position caused pain by pressure on the digital nerves in the sole of the foot. It should be treated, therefore, by pads beneath the anterior arch.

In 1894 Goldthwait,[2] of Boston, described the anterior transverse arch and its depression as a cause of pain similar to that described by Morton, in a much more thorough and convincing manner than had been done before. His conclusions were that obliteration of the transverse arch was very much more common than depression of the longitudinal arch; that, although comparatively few persons were inconvenienced by it, yet in some instances patients suffered from pain either constant or paroxysmal, usually referred to the centre of the anterior arch, where a painful callus might be found. This location of pain was much more common in his experience than at the point described by Morton. The causes of depression of the anterior arch were similar to those of depression of the longitudinal arch—viz., excessive standing or walking, injury, weakness after a long illness, and probably improper shoes, particularly those which were too narrow. The depression of the anterior arch might be demonstrated by an impression of the sole, which would show the absence of the re-entering angle at the base of the great toe. The condition might be relieved by placing a pad of felt or leather beneath the depressed bone or bones, or, if the affection was combined with depression of the longitudinal arch, a flat-foot brace should be employed.

In a recent paper on this subject, Jones,[3] of Liverpool, recognized depression of the anterior arch as a cause of symptoms, but he considered this to be in most instances secondary to flat-foot. The characteristic pain was not caused by pinching of the nerves (Morton's theory), because the metatarsal bones are separated when the arch is depressed; it was the result of the direct downward pressure of the misplaced bones upon the plantar nerves in the sole of the foot,

[1] Medical Record, January 18, 1890.
[2] Boston Medical and Surgical Journal, vol. cxxxi. p. 233.
[3] Liverpool Medico-Chir. Journal, January, 1897.

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practically Woodruff's theory. All of the cases were treated by resections of the head of the bone at the seat of pain, and in four instances two metatarsal bones were resected. The after-treatment was by means of thick-soled shoes, raised on the inner border as advocated by Thomas for the treatment of flat-foot, with well-fitting insteps to support the arch. Jones states that this theory of direct downward pressure on a nerve is supported by an observation of Tubby, who examined a portion of a nerve removed at an operation, and found it to be congested and swollen. It is of interest in this connection to note that Woodruff[1] described a case of what he called incomplete luxation of a metatarso-phalangeal joint, in which symptoms similar to those described were caused by a slight upward displacement of the first phalanx upon the fourth metatarsal bone. Guthrie[2] also reported a case in which intense pain was caused by overextension of the third phalanx upon the second.

A comparison of the reported cases that may be included under the term anterior metatarsalgia is of interest as bearing on the question of etiology. As no mention of other weakness or deformity is made by Morton, one may conclude that he considered the foot to be otherwise normal, yet depression of the anterior arch was present in many of the cases described by others.

In Bradford's sixteen cases the arch of the foot was normal, while in twelve of the fifteen cases reported by Jones in which the appearance of the foot was noted it was depressed, and flat-foot is considered by him to be the most important factor in the etiology.

In practically all of the earlier cases the pain was referred to the fourth metatarso-phalangeal articulation. On the other hand, Goldthwait states that the pain of metatarsalgia is much more common at other points in the anterior arch. Eight of Morton's cases were caused by injury; none of Bradford's. In all of Jones's cases, and in all of those reported by the younger Morton, resection was performed, yet in the practice of Bradford, Gibney, and Goldthwait the operation had never been required.

Depression of the anterior arch is said to be the result of long standing or of overwork, yet anterior metatarsalgia is more common in women than in men. Flat-foot is alleged to be a direct cause of

[1] Loc. cit. [2] Loc. cit.

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this depression, yet typical Morton's neuralgia is almost never a symptom of flat-foot.

As regards the actual symptoms of anterior metatarsalgia, there is little difference in the accounts of the writers on the subject, and, as has been stated already, the original description of Morton included all the important points.

The affection is relatively uncommon in hospital practice; it is more common in females than in males. Of 84 cases collected from the sources mentioned (including 21 of my own), 64 were in females and 20 in males. It is not an affection of early life, the average in 64 cases being thirty-three years, although in many instances the symptoms had been of long duration. As to the location of the pain, in 60 cases it was referred to the fourth metatarso-phalangeal articulation, in 6 cases to the third and fourth, in 6 to the three middle toes, and in but 6 was the fourth articulation free from pain. Of my own cases, the cramp was felt in both feet in 6, in 9 in the right only, in 6 in the left; in 14 cases the pain was referred to the fourth toe, in 3 cases to the third, in 2 cases to the second, third, and fourth, in 1 case to the second, and in 1 case to the third and fourth. In 3 cases there was marked depression of the longitudinal arch, in 3 cases slight weakness of the arch, in 2 cases an exaggerated arch, and in 13 cases the arch was normal. In 3 cases the symptoms were ascribed by the patients to tight shoes, in 3 cases to injury, in 1 case to "nervous prostration," and in 14 cases no cause could be assigned.

The pain or cramp is in some way favored by wearing a shoe; it is practically never felt at other times except in the very advanced and chronic cases. The cramp may begin as a sharp stinging pain at the fourth toe, or as a burning pain beneath the joint, or as a feeling of discomfort that gradually increases until it becomes unbearable. The pain is often intense, "like a toothache," "sickening," "like a hot coal," and the like; and unless it is relieved it spreads from the original site to the extremity of the toe, to the dorsum of the foot, and up the leg. The pain is relieved by removing the shoe, and patients often wear shoes that permit removal with a single motion of the other foot. When the shoe is off the patient seizes and compresses the foot, rubs the dorsum, flexes and extends the toes, and the like. Not infrequently the cramp is preceded by

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a sensation of something slipping or moving in the foot, and in such instances a similar snap often precedes the relief of the symptoms. After cessation of the pain a certain soreness and discomfort remain, and at all times the affected articulation is, as a rule, sensitive to deep pressure. The cramp is induced in some instances by a misstep or sudden movement, by overextending the toes as in stooping, or simply by overexertion or long standing; but in the well-marked cases of habitual cramp no apparent cause, other than the pressure of the shoe, can be assigned ordinarily.

The affection is extremely chronic, but occasionally spontaneous recovery may take place; in such cases a particular pair of shoes receives the credit of the cure, and in reality the most marked peculiarity of the cramp is that the pain is induced by the shoe and is relieved by its removal. Minor degrees of pain of the nature of metatarsalgia must be common. Morton states that the affection is well known to shoemakers, and almost every patient that I have seen knew of others who suffered in a similar manner.

The quotations from the literature of the subject make apparent the uncertainty that exists as to the meaning of the term anterior metatarsalgia, as well as to its cause and to its treatment. If in the typical cases the foot is otherwise normal, as is implied by Morton, or if no definite cause for the symptoms can be assigned, one must accept the barren theory that the pain ultimately depends upon the anatomical construction of the foot, and content himself to remove the head of a normal bone because it serves as a point of counter-pressure in pinching a nerve.

On the other hand, the theory that the pain is the result of an acquired weakness, either of structure or function, corresponds with what is known of other affections of the foot. It is therefore more reasonable, and from the therapeutic stand-point a much more hopeful conclusion; for if weakness and deformity can be recognized, they may be prevented as well as cured by appropriate treatment. I shall therefore call your attention to the anterior metatarsal arch and to its weakness, as a possible cause of the affection under consideration; and I shall attempt to explain the mechanism of the symptoms and to reconcile, if may be, the apparent contradictions that the literature of the subject presents.

The metatarsal arch is, of course, not a permanent arch, for when

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weight is borne the heads of all the metatarsal bones are on the same plane and the arch is obliterated. The head of the third bone bears the most weight, as is shown in normal feet by a callus or thickening of the skin beneath it. The outer and inner borders of the arch formed by the first and fifth metatarsal bones are provided with special muscles to aid in balancing and supporting the weight, and normally the toes also assist the arch and relieve it of a part of the strain of walking. When the weight is removed from the anterior arch it re-forms, the second and third metatarsal bones springing upward above the level of their fellows.

One notices now on looking at the sole of the foot the rounded muscular projection of the great-toe joint and at its outer side a fold or depression, indicating the highest point in the arch. By a weak or depressed anterior metatarsal arch one means that its natural resiliency is lost, the front of the foot seems broadened and flattened, and in some instances there is a distinct downward projection at its centre, the normal prominence of the great toe having disappeared. This downward projection may be the result of a loss of tone simply, or it may be a fixed deformity, so that it is difficult to raise the arch even by manipulation. In other instances the foot may appear to be perfectly normal, even in cases of typical neuralgia.

Although the arch is always obliterated when weight is borne, yet the imprint of a normal foot differs from that of one in which the arch is weakened or depressed. In the latter instance the tissues are somewhat flabby and spread out under the weight, occupying a larger surface, and thus encroach upon the clear space representing the longitudinal arch. The absence of what Goldthwait calls the re-entering angle, which represents a part of the hollow between the first and second metatarsal bones, distinguishes the imprint from that of the perfectly normal foot; but imprints, like other forms of graphic demonstration, are of more service in showing evident deformity than of value in early diagnosis.

Why should weakness or depression or other abnormal condition of the metatarsal arch cause symptoms such as have been described? This has never been adequately explained. One may understand how depressed metatarsal bones pressing on the sensitive tissues of the sole, as described by Woodruff and Jones, might cause constant pain or discomfort, but it is somewhat difficult to explain intervals of

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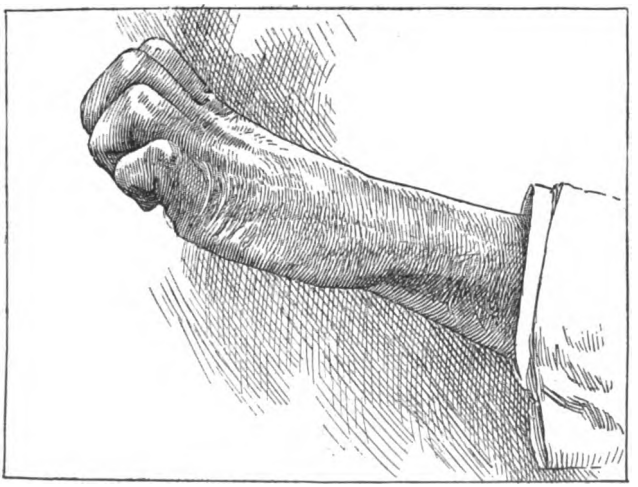
comfort, lasting, it may be, for weeks, alternating with paroxysms of pain, if all varieties of the affection are to be ascribed to this cause.

In studying a disability in which some slight change from the normal condition is suspected, one must begin by an examination of the structure and function of the normal part and of its peculiarities, and it occurred to me to utilize the hand as a more convenient member for observation than the foot. The hand and foot resemble one another closely; there are, more particularly, the same anatomical arrangement of nerves and the same relative shortness and mobility of the fifth metatarsal bone, that Morton considered of so much importance in the etiology of the affection. The metacarpal arch is composed, however, of but four bones, while that of the foot has five; but, as the first metatarsal bone has never been accused of participating in the neuralgia, this difference is of less importance than it would otherwise be. The anterior arch of the hand is in-

FIG. 1.



creased in depth by flexing the fingers; it is diminished by hyperextension of the fingers; that is, on hyperextension the heads of the metacarpal bones become prominent in the palm, the middle bones being on a somewhat lower plane than the other two. If the relaxed hand is squeezed or compressed laterally, it will be noticed that the anterior metacarpal arch is increased in depth, the hand is as it were

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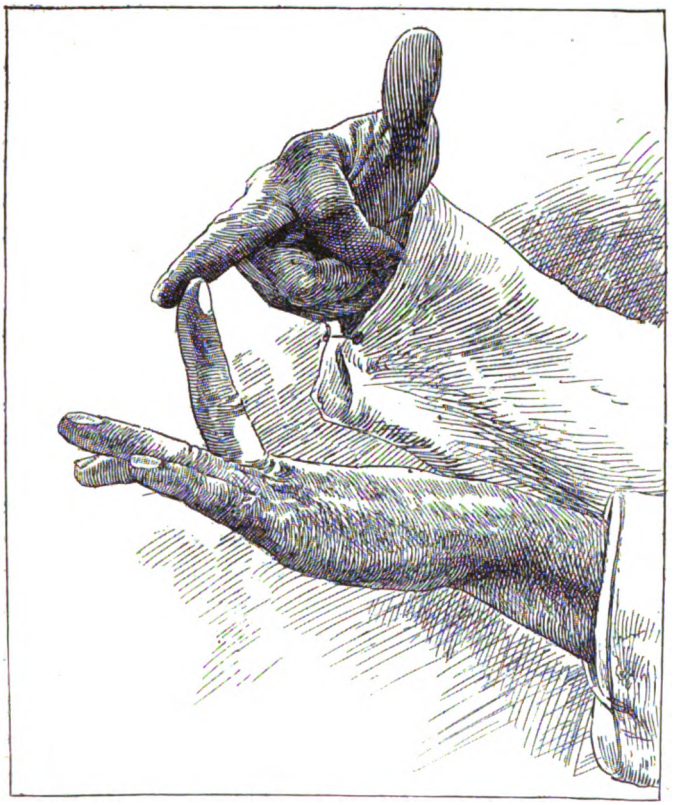
folded together, the heads of the third and fourth metacarpal bones project on the dorsal surface, and compression causes no pain. If, however, the fingers are held in an attitude of hyperextension, so that the arch is depressed and fixed and the hand is thus not allowed to fold together (Fig. 1), firm lateral pressure causes great pain at the junction of all the metacarpal heads. Or, if one extended finger

FIG. 2.



is forced backward (hyperextended) to its extreme limit (Fig. 2), lateral pressure on the hand causes extreme pain at or about the head of the depressed bone. If with the finger in this attitude deep pressure is made on one or the other side of the depressed head of the bone in the palm, a point of greater sensitiveness, representing apparently the digital nerve, can be made out. The same experi-

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ment may be made upon the normal foot with the same result. Dorsiflexion of the toes, more particularly of the second and third toes, depresses the metatarsal bones and fixes them in line, so that lateral pressure causes pain by forcing the joints against one another. Dorsal flexion of one toe forces the corresponding metatarsal bone downward, and lateral pressure causes pain, always at the point of depression. If, with the toe held in extreme dorsiflexion, weight is placed under the foot, the projecting bone in the sole will be found sensitive to the pressure, and by manipulation the same particularly sensitive points, apparently representing the nerves, may be made out. In the hand, the fourth metacarpo-phalangeal joint, and in the foot the metatarso-phalangeal joint, will be found to be most sensitive to these manipulations, probably because of the greater mobility that allows the greater depression, and because the pressure can be more directly applied by the external and overriding bone.

If the conclusion be accepted that depression of the anterior arch predisposes to pain on lateral pressure, even in the normal foot or hand, one may appreciate the importance of such an abnormal attitude, whether it be occasional or habitual in the foot, which must support the weight of the body and which is often subjected to lateral pressure by the shoe.

Again, if there are distinct types of the weakened or depressed metatarsal arch, it is reasonable to infer that there will be a corresponding variation in the symptoms. For example, one recognizes:

1. A rigid depression of the anterior arch, somewhat similar to rigid flat-foot, in which the front of the sole forms a general rounded prominence, in which the toes are dorsiflexed, and in which the arch cannot be re-formed by manipulation. As one would expect in such cases, the pain referred to the front of the foot is more or less constant on use. It appears to be caused by direct pressure on the sensitive and depressed joints, and by lateral pressure of the joints upon one another, aggravated by sudden movements, which may cause pain more or less neuralgic in character, although not limited to one articulation. One case of this type seen recently had been treated previously by removal of the fourth toe and the greater part of its metatarsal bone, but without relief of the symptoms, a result that might have been predicted from the nature of the deformity.

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2. Simple non-rigid depression of the anterior arch. In this type the front of the foot is broadened on general relaxation of the tissues, and it may or may not be combined with flat-foot. In many instances the condition may exist without causing noticeable symptoms, or they may be masked by the more positive discomfort due to weakness of the longitudinal arch, but in general one would expect the symptoms caused by the increased pressure upon the heads of the metatarsal bones, the painful callus, and the burning pain beneath the joints at the centre of the arch. If, however, such a relaxed foot were subjected to lateral pressure, as from a narrow shoe, then the twinges of neuralgic pain referred to the middle of the arch or to the fourth metatarsal bone might be expected, and as a matter of fact such symptoms are complained of in a certain proportion of the cases. If the longitudinal arch is weak, the foot lengthens under use, and thus affords the opportunity for lateral pressure by the narrow part of the shoe. That sufferers from flat-foot do not oftener complain of the symptoms of this lateral pressure is due, doubtless, to the fact that the abduction characteristic of the broken-down arch relieves the front of the foot from strain by transferring it upon the arch and inner border.

3. Cases of typical Morton's neuralgia, in which, in many instances, the foot may appear to be perfectly normal; in others slight weakness of the longitudinal arch may be present, but more probably an effect than a cause, and in others, as has been stated, depression of the longitudinal or the anterior arch, or both, may be present.

In the cases in which no apparent deformity exists it may be inferred that the natural or abnormal mobility of the fifth metatarsal bone allows it to override the fourth (not to roll above and under it, as Morton suggested), and thus to cause painful pressure in the manner already demonstrated. This assumption is supported by the following evidence:

1. Violent pain may be induced by lateral pressure on the hand when the fifth metacarpal bone overrides the fourth, but not when they are in the opposite relation.

2. Characteristic pain may be induced in the foot by a similar manœuvre in patients who are subject to the cramp.

3. Morton's neuralgia is often preceded by a burning pain

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beneath the toe, apparently due to pressure on a sensitive depressed joint.

4. It is often preceded by a sensation of something moving or snapping, and relief from pain is preceded by a similar snap.

5. Relief is experienced by flexing and extending the toes and by compressing the foot, procedures that would tend to replace a depressed bone; and, finally, several cases are on record in which elevation of a depressed metatarsal bone or toe was a necessary preliminary to relief of pain.

One may conclude, then, that depression of the anterior arch predisposes to pain because of the weakness of its muscles and its ligaments; thus the joints and the tissues of the sole are subjected to abnormal pressure in standing and walking. Also that the depression affords the opportunity for direct lateral pressure by the shoe and by sudden movements that may force the joints one against another. If the depression of the arch is general and equal, as in the flabby or in the fixed type, typical neuralgic pain is unusual; more often patients complain of symptoms that are due to direct pressure on the joints, often aggravated by or entirely dependent on a sensitive callus or fibroma near the middle of the arch at the point of greatest pressure. If, however, relaxation of the parts permits one bone to fall below its fellows, then lateral compression will cause the characteristic pain. The opportunity for abnormal depression and lateral pressure is greatest at the fourth joint, because of the mobility of the fifth metatarsal bone, which allows it to assume the overriding attitude, and because of its exposed position in the shoe. For this reason typical neuralgia may be a disabling symptom, although the foot appears to be normal in structure and function.

The theory that has been outlined will explain the positive effect of the shoe in the causation of the pain. When the entire arch is depressed, or when a bone in the arch is liable to displacement, the shoe may induce the cramp, because it provides lateral compression and at the same time elevates the heel, thus throwing more weight upon the front of the foot. That elevation of the heel has an influence in the causation of the pain is proved by the fact that patients subject to the cramp are usually more comfortable in walking up than in walking down an incline.

It is a common subject for speculation among patients, particularly

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those who suffer from occasional cramp, why one shoe is comfortable while another almost inevitably induces the pain, although the comfortable shoe may be the narrower one. The explanation is not difficult; if the tight shoe compresses the foot, as the tight glove compresses the hand, that is, folds it together, as it were, the anterior arch is elevated; but if the shoe does not support the arch in this manner, and if it is still sufficiently narrow to exert pressure, or if, as is often the case, the sole of the shoe beneath the arch is curved slightly downward, one or more of the metatarsal bones, held firmly within the shoe, may be gradually or suddenly depressed below the others, and the cramp follows. Thus one may explain the onset of the pain after a long walk or sudden exertion or misstep, or even after long standing. Frequent recurrence of the cramp signifies then displacement, pressure, irritation, and injury, that must cause a sensitive condition of the joint and of the surrounding tissues. Thus one may understand how, when the cramp habit has been acquired, very slight causes may induce the pain, and how nervous debility, weakness, or rheumatism or allied affections may aggravate its effects.

It will be noted that pressure on joints, displacement, and injury somewhat of the nature of a strain or contusion, as evidenced by the symptoms of local sensitiveness, and in some instances by local swelling and discoloration, are considered of the first importance in the explanation of the characteristics of the affection. My own observations in the dissecting-room do not support the hypothesis that the peculiar distribution of the external plantar nerve explains location of the pain at the fourth joint. The distribution of the digital nerves and of their articular fibres is practically identical at all the joints; the pain is most often located at the fourth metatarsophalangeal articulation because that offers the most favorable opportunity for pressure under the predisposing conditions.

If one must infer that a nerve is directly pinched by the apposed bones, it should be not a plantar but a dorsal digital nerve, as the pain is almost always felt in the dorsum of the foot and the outer side of the leg when it is referred to more distant points. If the plantar nerves are injured, it must be by direct pressure, as Jones has suggested. Deep pressure upon the lateral aspect of the plantar or palmar surface of the joints in the foot or hand causes acute pain,

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apparently due to compression of a nerve, as one may demonstrate upon himself; this probably accounts for the burning sensation, "the hot coal" beneath the toe, of which patients complain. At all events, direct pinching of nerves or neuritis is of secondary importance, and, in many instances at least, of very doubtful probability. Therefore, a painful condition of the front of the foot, due to weakness and injury, would describe the affection under consideration more accurately than "a painful condition of the plantar nerves."

What are the causes of the depressed metatarsal arch or of that condition of weakness that predisposes to pain?

One form of weak arch may be due, as has been suggested, to laborious occupation, or it may be a part of a general weakness of structure or secondary to flat-foot; but this explanation does not account for the facts that the cramp is more common among women than among men and that the affection is certainly as frequent among those who are able to rest the feet as among those who are overworked, and, finally, that the pain may be an occasional or a frequent symptom when the arch appears to be perfectly normal.

It is more reasonable, it seems to me, to ascribe the affection to that most constant and commonplace cause of pain, disability, and deformity of the front of the foot, the shoe. This is not only the exciting cause of the immediate symptoms, but it is the most important of the predisposing causes as well, because of its weakening effect upon the natural supports of the foot.

Under normal conditions the anterior arch should, by the assistance of the toes, be relieved from a part of the direct strain of walking, but ordinarily the toes are practically thrown out of function; they are squeezed laterally by the narrow and misshapen shoe and are lifted off the ground by what I have called the rocker shape of the ordinary sole.[1] If, for example, a patient's hand is presented for examination, it is held with the fingers extended, but if one examines a foot he will notice that the toes are, in most instances, drawn upward and backward, that they are semiflexed, like retracted claws, and that the range of plantar flexion is much limited. As plantar flexion elevates the anterior metatarsal arch, the test of this range of motion of the toes is of importance. If the arch is depressed and rigid, flexion of the toes is impossible, and even if it is simply de-

[1] Medical News, August 14, 1897.

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pressed from weakness, the range of flexion is much restricted. In the ordinary shoe the fifth metatarsal bone almost invariably overhangs its base of support, that is, the sole, so that the fourth metatarsal bone is, in most feet, the outer support of the arch, and occupies a lower level than the fifth, as may be demonstrated in the dissecting-room or upon the living subject.

This relative elevation of the fifth metatarsal bone, an attitude that predisposes to painful lateral pressure, is extremely common, and one may infer that this elevation or abnormal position might easily be increased to the extent of causing painful pressure, although the remainder of the arch might be normal.

If one accepts the shoe as a predisposing factor in the etiology, it becomes clear at once why women, who wear shoes with narrower soles and higher heels, suffer more than men, and why the affection is as common or more common among those of luxurious habit than among those in poorer circumstances, whose ideas of beauty must be subordinated to necessity.

Anterior metatarsalgia is, of course, a very remote consequence of improper shoes, and the fact that distortion of the feet is so universal and yet disability so comparatively infrequent shows the reserve force and accommodative power of nature. It has even become a very general belief that the toes are relics, having at the present time no particular function, and that they are, in fact, rather a nuisance and a source of pain than of practical value to their possessor. This belief is founded upon the erroneous idea, doubtless, that painful and distorted toes are the necessary consequence of wearing shoes.

Admitting the influence of the shoe as a cause of weakness in general, and as the direct cause of the cramp in those who are subject to it, one must recognize many other causes, direct or indirect, of the symptoms. For example, injury or a strain or over-exertion may weaken the ligaments or increase the sensitiveness of parts already weakened. Hereditary influence appears to be of some importance, if one may trust the histories of patients. Increased local susceptibility to pain, due to gout or rheumatism or general depression of the system from any cause, may aggravate and prolong the symptoms. In fact, many of the patients appear to be of what might be called a nervous type.

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Slight weakness of the longitudinal arch is not uncommon as an accompaniment of anterior metatarsalgia, but in many instances this is a secondary and not a primary condition. Direct flattening of the arch may aggravate the symptoms by affording greater opportunity for lateral compression by the narrow shoe, and, on the other hand, the exaggerated arch may increase the severity of the symptoms by throwing more strain upon the heads of the metatarsal bones.

On the theory that the cause of the pain in metatarsalgia is pressure, acting upon a depressed anterior arch or upon an arch in which a metatarsal bone is liable to displacement, one can readily account for the efficacy of the various procedures that have been advised. The wide, thick-soled shoe splints the foot, retains the metatarsal bones on an even plane, and thus prevents lateral pressure and sudden twists. The bandages and strapping about the metatarsus give relief by steadying the metatarsal bones and by supporting the anterior arch, not by separating the heads of the metatarsal bones. The Spanish arch or the foot-plate is efficient because it removes a part of the weight from the sensitive joints and holds the foot firmly in one position, thus preventing its elongation in the cases in which it is actually weakened. The efficacy of pads or braces beneath the anterior arch is obvious, as is the resection of the part of the metatarsal bone against which pressure is made.

The first essential in treatment is to provide the patient with a shoe of improved pattern with a low heel, a wide, thick sole, a well-fitting arch, and with abundant room for the toes. If the foot shows a tendency toward valgus, the heel and sole may be made slightly thicker on the inner border. The main point in the direct treatment is to support the anterior arch or to prevent the attitude that predisposes to pain. In the mild cases it may be sufficient to thicken the sole somewhat beneath the middle of the metatarsal arch, so that it may be slightly curved upward instead of downward, as is the usual construction. In most instances, however, more direct support will be required, and as an immediate treatment a pad of sole-leather about one-fourth of an inch in thickness may be placed directly behind the head of the metatarsal bone of the painful joint, where it may be fixed by adhesive plaster and further secured by encircling bands of plaster about the metatarsal region. If properly applied, the direct and indirect support of the pad and plaster will almost

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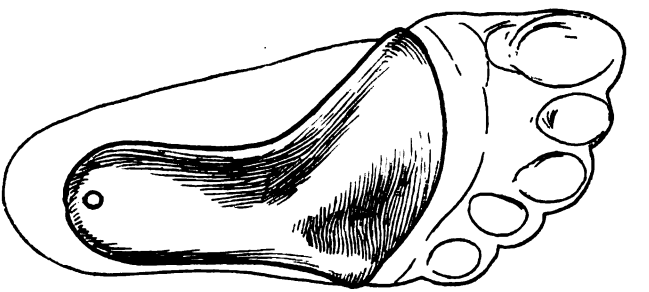
always relieve the symptoms. In some instances, after the pad has been worn until the most comfortable size and shape have been ascertained, it may be attached to the sole of the shoe, but, as a rule, pads of this nature and the adhesive-plaster strapping, although efficacious, require too much attention and supervision. A properly fitted metal support is, therefore, to be preferred. This should be constructed on a plaster cast of the sole of the foot, the plaster being hollowed out just behind the affected joint (*A*), where the highest point of support should be. The front of the brace should be slightly wider than the foot, so that it may hold its place in the shoe and prevent lateral pressure; it should be extended forward practically to the end of the sole, so that it may aid in steadying the sensitive part. Behind it reaches to the heel, its centre being raised somewhat to support the arch of the foot and to strengthen the shank of

FIG. 3.



the shoe. The brace is made of thin steel, and it is tempered after it has been accurately fitted to the foot (Fig. 3). If the longitudinal arch is perceptibly weakened or depressed a flat-foot brace may be employed, so modified as to support the anterior arch as well. In fact, the support of the longitudinal arch, either by the shoe or by a brace, to hold the foot in place and to remove a part of the weight from the metatarsal region as well as sustain it, is a most important part of the treatment, and in many instances patients may be relieved by this means alone. When comfort has been assured by the rest and support of the sensitive part and by the avoidance of what experience has shown to be exciting causes of the pain, the patient should endeavor to strengthen the foot by exercise, as well as by proper functional use, in order that permanent cure may be assured.

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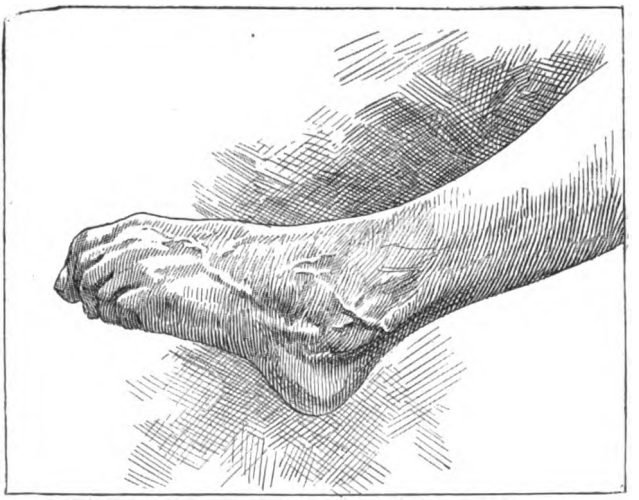
The best exercise for the front of the foot is alternate flexion (Fig. 4) and extension of the toes, in order to regain a part at least of their lost function. If the metatarsal arch is rigidly depressed, it must be made flexible by daily manipulation or by forcible correction under anæsthesia before a brace can be worn and before the toes can be flexed.

FIG. 4.



I have never been obliged to perform resection. This operation is, in any event, the treatment of an effect rather than of a cause. It has the theoretical disadvantage also of weakening the foot, and it causes a rather unpleasant deformity, as the toe always recedes between its fellows; in fact, the operation is indicated only in the severe and chronic class of cases or when proper treatment cannot be provided or has been proved to be inefficient.

If a patient were seen in the acutely painful stage of the affection that has been described as the immediate result of injury, and if the pain were persistent at or about the anterior arch, one should assure himself that the bones were in normal position, then support and fix the arch and the foot by a properly applied plaster bandage until the acute pain and sensitiveness of the part had subsided.

It is hardly necessary to describe in detail local and palliative remedies for pain that may be indicated in special cases. Most of them will have been tried before the patient applies for treatment.

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There are other painful affections of the front of the foot, in cause and symptoms somewhat similar to anterior metatarsalgia or that may be combined with it; for example, the painful callus beneath the centre of the arch. In some instances its removal will relieve the symptoms, but in most cases its underlying cause, the depression of the metatarsal arch, must be treated in the manner already described, before permanent cure can be attained.

When the longitudinal arch is exaggerated, as in the "contracted" foot, a row of painful corns beneath the projecting metatarsal bones may cause discomfort, and the condition may be accompanied by pain resembling that of metatarsalgia. In such cases treatment must include the reduction of the cavus and the correction of the equinus, if it be present.

The subluxation of the phalanx described by Woodruff appears to be practically identical in symptoms with ordinary metatarsalgia, and the subluxation is very probably preceded or accompanied by depression of the head of the metatarsal bone.

The following conclusions are presented for consideration: Morton's painful affection of the foot and the less definite symptoms that may be included under the term anterior metatarsalgia, although not identical, are nearly allied, in that an abnormal relation of the metatarso-phalangeal joints to one another, combined with pressure, is the cause of the symptoms. This abnormal relation is caused by an occasional or habitual depression of the anterior metatarsal arch or of one of the bones of which it is composed. Habitual depression of this arch is often combined with general weakness of the foot, and much of the discomfort is due to abnormal pressure on the depressed bones from beneath. Occasional and typical Morton's cramp may exist without obvious deformity, and in such instances it is caused by lateral pressure upon an overriding fifth metatarsal bone, due probably to an abnormal laxity of the ligaments. The most constant of the general causes predisposing to weakness of the front of the foot, as well as the most direct cause of the symptoms of discomfort in this region, is the improper shoe.

The cure of the condition may be attained by supporting the anterior arch, by avoiding the exciting causes of the pain, by correcting, if may be, abnormalities of structure or function, by strengthening the weakened foot by exercises, and by affording its mechanism the opportunity for functional activity by the use of a proper shoe.

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FURTHER STUDIES UPON THE ARCH OF THE FOOT IN INFANCY AND CHILDHOOD.

By JOHN DANE, M.D.,
BOSTON.

When one examines the foot of a healthy infant during the first two years or so of life, he cannot fail of being impressed with certain rather striking differences that it presents when compared with the foot of a normal adult or older child. The whole foot seems shorter and much thicker; moreover, the sole appears perfectly flat. This latter fact is still further confirmed if we have the child run over a board floor with wet feet, or stand upon the glass top of one of our new examination-tables. The imprint is unquestionably that of a flat foot. This is not, however, true of all children's feet; in some of the thin, ill-nourished ones we find the foot apparently as well formed and arched as in later life. Again, in rarer cases, we see the whole foot pronated at the ankle-joint and the bones as much displaced as in any case of pes valgus in the adult. But both of these latter classes are rare; most infant feet are as first described. This superficial resemblance to the true flat-foot—and I hope to be able to prove to you later that it is only superficial—has found its way into literature unchallenged, as the following quotations from the leading text-books on orthopedics will quickly show:

Taking those in German first, we find that Shreiber,[1] in speaking of "pes planus," says that "the foot of the new-born infant is always flat, and we may consider pes planus the outcome of absence of that phase in growth which leads to the arching of the foot." Hoffa,[2] in his *Lehrbuch*, says: "It now remains for us in a few words to speak of the so-called 'plattefuss.' This plattefuss, the 'pes planus,' is characterized by the absence of the outer foot-arch."

[1] Shreiber: "General Orthopedics." Translated in Wood's Medical Monographs, p. 257.
[2] Lehrbuch der Orthopädischen Chirurgie. Dr. Albert Hoffa. 1st Auflage, 1891, Seite 691.

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It would seem, however, that he refers to the inner arch as well, for a few lines further on he describes it as having the "tuberosity of the scaphoid rest upon the underlying base and forming the lowest point of the inner edge of the foot." He goes on to say that "The foot of the new-born is always flat. First, at an early stage of life, during the exercise of function, the bones of the outer row are built up into an arch through the process of growth. The plattefuss is, therefore, to be regarded as a failure in that process of growth; accordingly, in a way, as an arrest of development." Lorenz,[1] in his wonderful monograph, looks at it in the same way, saying: "We must, therefore, regard pes planus as the result of a failure in the process of growth through which the child's foot, always a perfectly flat foot, through its function, and even in spite of its function, raises itself into an arch." In France the general opinion is well shown by the following, taken from the *Chirurgie Orthopédique* of Redard.[2] He says: "In the new-born the foot is flat; we can even find in some subjects, in place of a slight concavity, a well-marked convexity of the sole of the foot. The plantar arch forms only when the children begin to walk."

Taking up now the American text-books on this subject, we find in Bradford and Lovett[3] the statement that "the sole of an infant is flatter than that of an older child. It is slightly turned in, and the absence of an arch may be seen by the tracing taken on smoked glass from the foot of a child ten months old. The arch begins to form at about the age of one year." A later work, that by Dr. Young,[4] of Philadelphia, says: "It is, moreover, a well-established fact that all infants, on commencing to walk, are flat-footed, and do not acquire a perfect plantar arch until they have exercised some time and the leg muscles have become developed." He then refers to a piece of work done on the subject of the so-called building up of the arch, published by me in 1892, which I shall criticise later. Our latest work, that by Dr. Moore,[5] of Minneapolis, has the statement that, "in children, the arch of the foot does not begin to form until after the first year. Weak ankles of children are really a form

[1] Die Lehre vom Erworbenen Plattfusse, Dr. Adolph Lorenz, 1883, S. 54.
[2] Traité Pratique de Chirurgie Orthopédique, par le Dr. P. Redard, 1892, p. 799.
[3] A Treatise on Orthopedic Surgery, by E. H. Bradford and R. W. Lovett, 1890, p. 729.
[4] A Practical Treatise on Orthopedic Surgery, by James K. Young, 1894, p. 339.
[5] Orthopedic Surgery, by James E. Moore, M.D., 1898, p. 134.

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of valgus, due to lack of development of the arch and to weakness of the tibialis anticus, tibialis posticus, and plantar muscles. These children are free from pain, but have a characteristic gait, and frequently fall and sprain the ankle."

Turning now to the British works, we find, in general, the same statements, yet with just a hint of something else. Thus, in Walsham and Hughes:[1] "The feet of new-born children are flat, and although there is an inherent tendency for the bones in their development to take the shape and position of the bones in the normal adult foot, it is not until the child begins to walk and the muscles are brought into vigorous action that the arch is fully formed. In the normal foot of the infant, however, there is no valgus—*i. e.*, eversion or abduction; indeed, the foot naturally assumes a slight tendency toward the varus position—*i. e.*, it is rather adducted than abducted, inverted than everted. The absence of the arch of the foot in the infant does not constitute the condition known as congenital valgus, or flat-foot. Some children, however, never develop a proper instep; the sole remains more or less flat, retaining, so to speak, the infantile form." Lastly, in his recent work on *Deformities*, Mr. Tubby[2] says: "In all young infants the arch of the foot is absent, so that the deformity may not become apparent until the child begins to walk." Again: "In infants the sole of the foot is always flat, on account of the presence of a large amount of fat in that situation, the small size of the tuberosities of the os calcis, and the absence of the arch. The latter originates from the stimulus of walking acting on the long and short muscles of the foot. A state of flat-foot is common among certain races, especially the Jew, Negro, and Kabyle, and is hereditary. It is a persistence of the normal state of the feet at birth."

Such is, without a single exception, the teaching of authority as regards the condition of the arch of the foot in infancy. It is said simply not to exist; it only comes into being as it is formed, little by little, by the action of the muscles as the growing child begins to use them. There is, indeed, a hint of something different in the last quotation given, that from Mr. Tubby, for he speaks of the presence of "a large amount of fat" in the infant's foot; but he seems to

[1] The Deformities of the Human Foot, by W. J. Walsham and W. K. Hughes, 1895, p. 387–88.
[2] Deformities: Treatise on Orthopedic Surgery, by A. H. Tubby, 1896, pp. 358, 361, 469.

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regard this as nothing but an envelope, for he distinctly states that there is "an absence of the arch," and goes on to describe the arch as being built up just as his predecessors had done.

In my own earlier work[1] I was misled, to a great extent, in the same way. This was largely owing to the fact that I was working, for the most part, with the wet-tracing method. From the study of a series of about four hundred footprints, taken from children ranging from nine days to fourteen years, the following deductions were drawn: "At birth the foot does not seem to be flat, as is the general impression. There seems to be, on the contrary, a distinct arch in the feet of most infants, better formed in one foot than the other, and persisting until they are about eighteen months old. In this period the difference in the arch of the foot between males and females is not noticeable. After eighteen months there begins to be a distinct breaking down of the arch, which in most cases is wholly lost, the two feet suffering equally. For the next year and a half the feet remain distinctly flat, yet even during this period isolated tracings appear in which the arch is never lost. It is interesting to note that such are always females, and, therefore, presumably lighter children. During the next (third) year the arch is slowly rebuilt, one foot improving before the other, and the females considerably earlier than the males. When the fourth year has been well entered upon the feet have nearly reached the adult condition; the two are about alike, and there is no marked difference between males and females." Figs. 1 and 2 are from a typical set of these footprint impressions as originally published.

As the study was carried further, however, two sets of facts argued against the truth of these deductions: first, a series of measurements relative to the height of the tuberosity of the scaphoid above the level of the sole of the foot; and, second, an examination of hardened sections of such infants' feet as could be obtained for that purpose. Table I. shows in detail the measurements taken in a series of thirty-eight cases. These were made in the following way: Three points were marked upon the skin of the inner side of the foot—one over the metacarpo-phalangeal joint of the great toe, a second over the tuberosity of the scaphoid, and the

[1] "A Study of Flat-foot." Boston Medical and Surgical Journal, October 27th, November 3d and 10th, 1892.

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FIG. 1.

Tracings of female feet; ages four weeks, three months, fifteen days, one year, one year six months, two years, two years six months, three years, three years six months, four years, five years one month, six years, eight years.

FIG. 2.

Tracings of male feet; ages four weeks, three months, one year two months, one year ten months, two years, two years six months, three years, three years six months, four years, five years seven months, six years three months, seven years.

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third as nearly over the hindmost point of the bearing surface of the inner tuberosity of the os calcis as could be determined. A flat piece of wood was pressed firmly against the sole of the foot, while the knee and thigh were controlled by the hands of an assistant. It was then easy to measure the height above this plane of the point over the tuberosity of the scaphoid, thus getting the actual height of the arch. The span of the arch was found by measuring the distance in a straight line between the outer two points. The average height for infants of one year or under was found to be 1.651 c.m.; between one and two years, 1.510 c.m. (For details, see Tables I. and II.). Or, taking the proportion of the height of the arch to its

FIG. 3.

Feet from an infant, premature at the seventh month. Died one week after birth.

length, we have the fractions 0.301 and 0.218 as the average for the same periods of time. The adult proportion is about 0.270. This is not exactly what one would expect to find if the feet were really flat; for it shows that the essential structure—that is to say, the arch formed by the bones—not only exists at the earliest period of life, but that it is fully as high proportionally at this as at any subsequent time.

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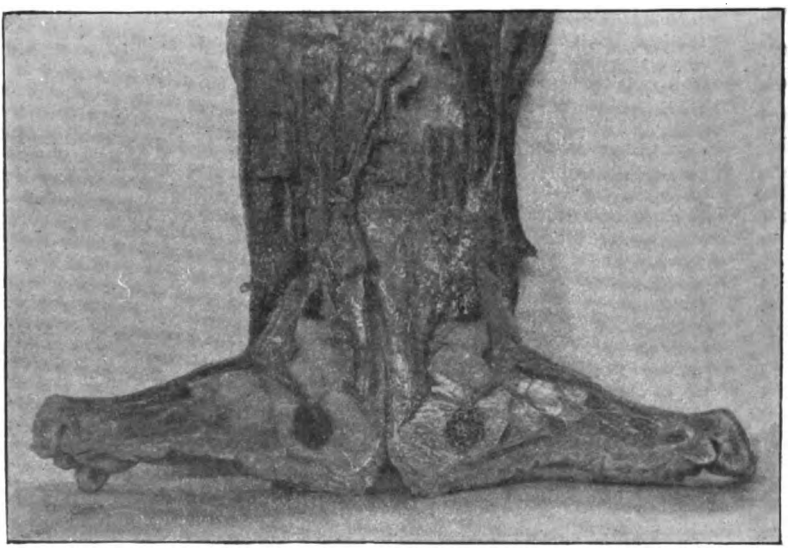
Turning now to the examination of the hardened sections, the explanation of the discrepancy between the measurements and the

FIG. 4.



Longitudinal section of the foot of an infant, premature at the eighth month. Died some days after birth.

FIG. 5.

Left foot of a child eighteen months old.

wet tracings is not difficult to see. The space that in the adult and older child is bridged over by the arch of the foot is in the infant and young child, if it is at all fleshy, entirely filled up by a pad of

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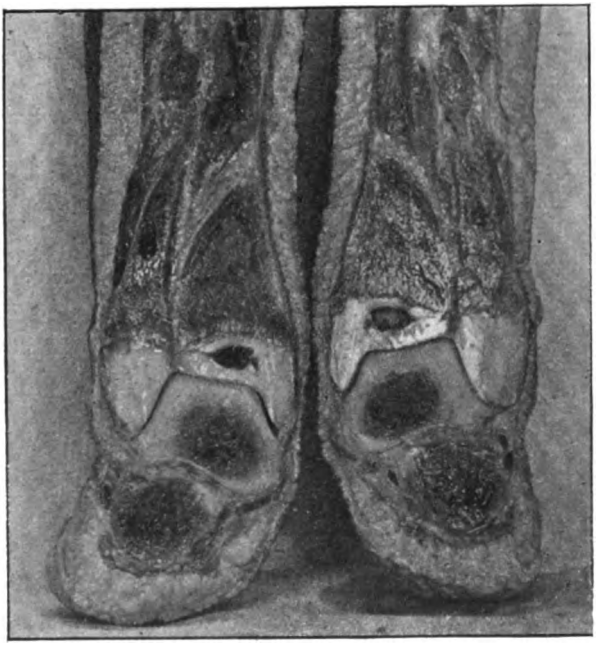
fat. It is the impression made upon the paper by this fat that has misled us into thinking that the foot of the infant had no arch. In thin children the pad is wanting, in which case the print of the foot strongly resembles that of the adult. Fig. 8 is a photograph from a pair of feet of an infant, premature at the seventh month. The whole infant weighed only a pound, but the feet are perfectly formed

FIG. 6.



Section of foot shown in Fig. 5, through ankle-joint.

and exquisitely arched. Fig. 4 shows a longitudinal section of the foot of an infant, premature at the eighth month. Fig. 5 shows the general appearance of a foot taken from a child eighteen months old. Figs. 6 and 7 are from sections of the same. Unfortunately, the child was far from plump, so that the pad of fat under the arch is not as well illustrated as I could wish; but the relation of the bones is well shown, and especially the upright position of the os calcis and the high level of the scaphoid. As a contrast, Fig. 8 (photographed from a specimen in the Warren Museum) shows the position of the

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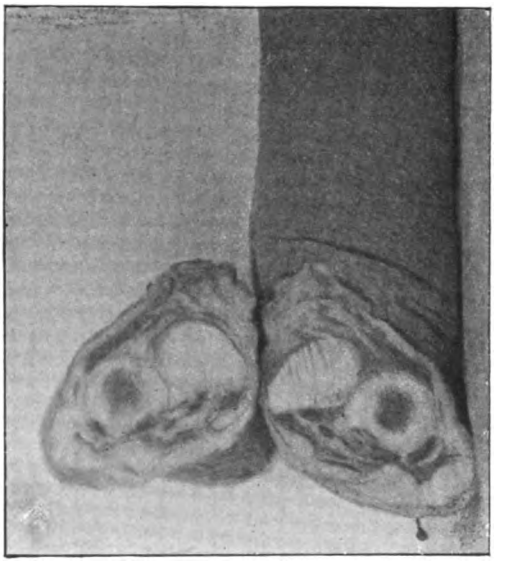
bones in a case of true congenital valgus. In studying this pad of fat I have found it present in a very few cases at birth. It is most in evidence from the first six months to the middle or end of the second year. It is then seen slowly to atrophy as the child grows older and the functions of the foot are more perfectly established.

FIG. 7.



Section of same at medio-tarsal joint.

It seems, therefore, that we must readjust our theories of the formation of the arch of the foot, and say that it exists as a perfectly formed structure in the vast majority of feet at birth. It is in no wise dependent for its beginning upon the action of muscles, etc., which cannot be supposed to become a factor of much importance until after the child has begun to walk; but yet, during the whole period from birth to eighteen months, the bones are growing, with their mutual articulations so adjusted as to form an arch, even from the first. Were it otherwise, the so-called "formation of the arch" later would be a very difficult, if not impossible, operation. The arch, however, although well formed from the beginning, would be a very weak structure if it depended for its support solely upon

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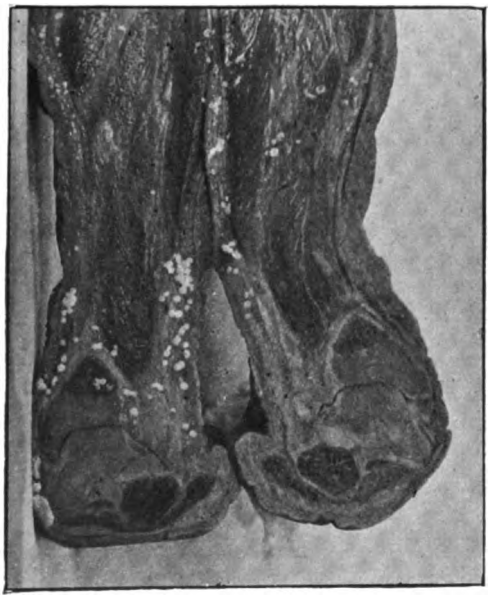
the ligaments binding the soft, cartilaginous bones together, even when reinforced by such addition as the feeble leg muscles of the infant could give it. Later in life the muscles should, of course, be amply strong enough to truss up the arch and render it capable of supporting the body-weight, even with the greater strain added by jumping and carrying burdens. Not so in the early period of life. The weight of the child would destroy the delicate structure of the arch long before the muscles were developed to a sufficient extent to prevent it, were it not for the *pad of fat* of which we have just

FIG. 8.



Section of a congenital valgus foot through middle of the ankle-joint. (Warren Museum.)

spoken. This pad fills in accurately all the hollow left by the bones, and gives a soft cushion upon which the bones rest until such time as the bones have become hard, the ligaments firm, and the leg muscles have, through exercise, gained sufficient strength to support the arch. Then, its use being over, the pad is gradually absorbed and the hollow formed by the arch appears in the wet tracing of the foot. Thus the arch can in no sense be considered as having "been formed" at this period ; it has only been, as it were, uncovered.

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TABLE I.—CHILDREN UNDER ONE YEAR—76 FEET.

No.	Length of arch. Right.	Length of arch. Left.	Height of arch. Right.	Height of arch. Left.	Age.	Sex.
1	4.2 c.m.	4.4 c.m.	1.3 c.m.	1.4 c.m.	6 weeks.	Female (Jew)
2	4.8 "	4.7 "	1.4 "	1.5 "	6 "	Male.
3	5.0 "	5.0 "	1.2 "	1.1 "	6 "	Female.
4	5.4 "	5.5 "	1.6 "	1.6 "	7 "	Male.
5	4.0 "	4.2 "	1.2 "	1.3 "	2 months.	"
6	4.8 "	5.2 "	1.2 "	1.6 "	2 "	"
7	5.0 "	5.0 "	1.3 "	1.4 "	2 "	"
8	5.2 "	5.0 "	1.7 "	1.6 "	2 "	"
9	5.4 "	5.2 "	1.5 "	1.4 "	3 "	Female.
10	5.4 "	5.4 "	1.7 "	1.5 "	3 "	"
11	6.2 "	5.8 "	1.7 "	1.6 "	3 "	Male.
12	5.3 "	5.5 "	1.5 "	1.5 "	4 "	"
13	5.4 "	5.3 "	1.6 "	1.6 "	4 "	Female.
14	5.6 "	5.6 "	1.5 "	1.7 "	4 "	Male (Jew).
15	5.8 "	5.7 "	1.8 "	1.6 "	4 "	"
16	4.7 "	4.7 "	1.4 "	1.5 "	4½ "	Female (Jew)
17	5.1 "	5.1 "	1.7 "	1.4 "	4½ "	"
18	6.2 "	6.0 "	2.0 "	1.8 "	5 "	"
19	5.5 "	6.0 "	2.0 "	1.8 "	6 "	"
20	5.6 "	5.8 "	1.7 "	2.0 "	6 "	Male.
21	6.4 "	6.4 "	1.8 "	1.7 "	6 "	Female.
22	4.8 "	5.0 "	1.8 "	1.2 "	7 "	"
23	5.4 "	5.7 "	1.5 "	1.6 "	7 "	Male.
24	5.8 "	5.5 "	1.7 "	1.7 "	7 "	Female.
25	5.8 "	6.2 "	2.0 "	2.0 "	7 "	"
26	6.0 "	6.0 "	1.8 "	1.8 "	7 "	"
27	6.0 "	6.0 "	2.0 "	1.8 "	7½ "	"
28	6.4 "	6.5 "	1.8 "	1.5 "	7½ "	Male.
29	5.0 "	5.0 "	1.5 "	1.6 "	8 "	Female.
30	5.0 "	5.2 "	1.4 "	1.4 "	8 "	Male.
31	5.1 "	5.0 "	1.8 "	1.4 "	8 "	"
32	6.6 "	6.6 "	2.0 "	1.7 "	8½ "	"
33	5.3 "	5.6 "	1.5 "	1.6 "	9 "	"
34	5.5 "	6.0 "	1.6 "	2.0 "	9 "	Female.
35	6.0 "	6.0 "	2.0 "	1.4 "	10 "	Male.
36	5.4 "	5.5 "	2.2 "	2.2 "	11 "	"
37	6.0 "	6.0 "	2.2 "	2.2 "	11 "	Female.
38	6.1 "	6.1 "	2.0 "	2.2 "	12 "	Male.

Average length of arch . . . . . 5.481 c.m.
" height of arch . . . . . 1.651 "
Proportion, length to height. . . . . 0.301 "

TABLE II.—CHILDREN BETWEEN ONE AND TWO YEARS.

No.	Length of arch. Right.	Length of arch. Left.	Height of arch. Right.	Height of arch. Left.	Age.	Sex.
1	6.0 c.m.	6.5 c.m.	1.8 c.m.	1.6 c.m.	13 months.	Male.
2	7.7 "	7.6 "	1.4 "	1.7 "	13 "	"
3	6.8 "	6.0 "	2.0 "	2.0 "	14 "	"
4	6.6 "	6.4 "	1.8 "	2.0 "	14 "	Female, negro
5	6.6 "	6.7 "	2.3 "	2.0 "	14 "	"
6	7.2 "	7.0 "	2.6 "	2.3 "	15 "	"
7	6.5 "	6.4 "	2.0 "	2.3 "	16 "	"
8	8.0 "	7.5 "	2.5 "	2.0 "	18 "	Male.
9	7.5 "	7.6 "	2.1 "	1.5 "	21 "	Female.
10	7.5 "	7.5 "	2.3 "	2.3 "	22 "	Male.

Average length of arch . . . . . 6.905 c.m.
" height of arch . . . . . 1.510 "
Proportion, length to height . . . . . 0.218 "

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As a practical conclusion, I would urge the use of the so-called "flat-foot plates" for children much more than I believe is at present the custom. Nature has shown us the principle by putting what may be called a physiological flat-foot pad in the feet of all stout, healthy children. Unfortunately, all children, as we see them in civilized life, are not healthy and fat, and in them the pad of fat under the arch is quite often wanting. It, therefore, seems to me our place as orthopedic surgeons to supply this deficiency at once by art, hoping thereby to save a useful and strong foot in place of one that will go on only too surely to flattening of the arch, pronation of the ankle, and all the series of troubles that accompany and follow these changes.

DISCUSSION.

DR. MYERS said he had seen several women who complained of anterior metatarsalgia. Examination showed that the anterior arch was relaxed and yielded on pressure. In several of these cases the tendo Achillis was shorter than normal, and the treatment adopted was to stretch this tendon to secure proper ankle flexion, and so relieve the anterior arch of extra strain. The metatarsal bones were then compressed by a circular bandage, so as to support the replaced arch. No special shoes need be worn, but they must fit closely about the ankle and metatarsal region, and allow plenty of room for the toes.

DR. R. H. SAYRE said that the elevated cork shoe exhibited seemed to him defective, in having the extension go up to the toe. The Chinaman cuts off the tip of the shoe, and as he goes forward he rocks on the inflexible sole like a boat. If the shoe were sufficiently flexible, so that the sole would follow the shape of the foot as one walks, it would be found to tip up at the level of the big toe. If the shoe were built so that one must walk as if the great toe-joint were anchylosed, walking would not be as comfortable. In one case of metatarsalgia that he had met with some years ago the patient could only get relief by riding on a bicycle and pressing the pedal up into the arch of the foot. This gave immediate relief to the pain.

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By gouging out a place in the sole of the shoe as a resting-place for the heads of the metatarsal bones, relief was afforded.

He had been very much interested in Dr. Dane's observations on hardened sections of infants' feet. He would like to know how these feet were prepared.

DR. DANE replied that some of them were frozen and then the sections cut. A few were hardened in formalin before being cut.

DR. S. KETCH, of New York, referred to a case seen recently—a woman about twenty-eight years of age, who had the painful affection of the foot now under discussion. She was the wife of a physician, and had tried all sorts of shoes and appliances. In her case there was a distinct gouty history, extending back two or three generations. She was put upon the classical treatment of gout, with the result that the symptoms were entirely and absolutely relieved by internal medication. The case was mentioned to serve as a caution against overlooking those cases which are due to constitutional conditions. Personally, he believed that most of the cases were due to general weakness and faulty mechanical conditions.

DR. L. A. WEIGEL, of Rochester, said that in a discussion of this subject several years ago he had expressed the opinion that many of the cases were dependent upon a general condition, and that the mechanical treatment would fail if the underlying general condition were overlooked. He had seen since then quite a number of cases of neuritis. A case was cited in which the diagnosis of neuritis had been mede by a prominent neurologist. When the case came under his observation he found a distinctly painful point in the foot, and similar tender points could be elicited over almost any other part of the body. There was a distinct history of injury to the foot, and objectively a marked flattening of the arch. The foot was supported mechanically by means of a plate, and she obtained relief, not only from the local trouble in the foot, but also from various other points of irritation in the body. The latter were apparently reflex. The mechanical support of the arch and attention to the shoe had not, in his hands, given the relief he had hoped and expected to obtain

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in most cases. He doubted very much the correctness of the explanation given by Morton of the pain experienced in these cases; certainly skiagraphs failed to show the condition.

Dr. Goldthwait said that the subject of metatarsalgia could hardly be discussed without referring to conditions affecting the anterior transverse arch. The paroxysmal or metatarsalgic type of pain is much more common in women than in men, and he had explained this by the fact that men wear wider boots, which allow the bones to rest more upon the ground. Many of the patients present a subacute periarticular inflammatory condition about the second or third metatarso-phalangeal joint. A very important part of the treatment was by means of exercise, because practically all of these cases have very weak flexors of the toes. He had recently seen a number of men on athletic teams at Cambridge with this very trouble of the anterior arch. These men, although having a wonderful physique, had no power of flexion of the toes. In quite a number of cases a permanent cure had been effected by attention to this one point. Another mechanical point not touched upon very much by Dr. Whitman is the fact that a good many of the cases have this paroxysmal pain, not from pinching of the metatarsal bone, but from the fact that in a very narrow, pointed shoe, when the weight is borne upon the feet, especially if the heels are high, the toes are crowded down and the pain results, not from the crowding of the metatarsal bones together, but of the first phalanx of the last toe against the head of the fourth metatarsal bone. Since bicycling had become so common, especially among women, he had seen many more of these cases. He attributed this to the crowding of the toes into the tip of the boot.

Dr. G. G. Davis, of Philadelphia, said that he understood that Dr. Galloway obtained eversion or inversion by raising the sole of the shoe. Another way was to raise the sole inside of the shoe. This made a neater and less bulky shoe. Where a shoe is high and unstable, a side-iron with ankle-joint may be inserted with advantage. The simple device of wrapping adhesive plaster around the fourth toe in these cases of Morton's toe he has found very useful.

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DR. JUDSON said that at one of the previous meetings Dr. Cook had presented a useful idea in connection with this subject. He had made the statement that it was the custom of veterinary surgeons to construct a horseshoe with a lateral extension, so as to control the way in which the hoof strikes the ground. This idea seemed to be presented in shoes having a wide lateral extension, either inward or outward. It brought up the idea that the control of club-foot by mechanical means is simply a method of leverage. The foot is a very difficult thing on which to obtain leverage. Dr. C. Fayette Taylor spoke of a certain type of foot as being a "potato foot," meaning by that that it was a very unstable thing for the patient to walk on, and also that leverage could not be easily applied to it. Dr. Galloway increases the leverage by a horizontal extension of the apparatus. In some cases it seemed to him more desirable to increase this leverage by relying on a perpendicular extension of the apparatus, as in the ordinary varus club-foot shoe. One difficulty which these shoes would have to meet was the liability of the foot to turn around in the shoe. This would be partly obviated by a vertical extension, whereby, with the aid of buckles and adhesive plaster, the foot could be kept from moving around much inside of the shoe. His experience had been that there was a great deal more trouble with the shoemakers than with the steelworkers.

DR. GRAHAM, of Boston, said that he personally had suffered from this painful affection of the foot, which was surely brought on by sitting for some time with the edge of the chair pressing on the thigh. Mental worry was also liable to excite the pain.

DR. KETCH said that, irrespective of what form of high shoe is used, many patients find that on bearing weight on the shoe the ankle will give way. He had often, therefore, found it necessary to supplement the high shoe by some lateral support at the ankle, such as lacing or an extra strap.

DR. GALLOWAY said, regarding the objection made by Dr. Sayre, that the joints of the toes still had independent motion inside of the boot. In practice, he had not found that patients were apt to stub the toe or trip. If the toe were cut off too much, it simply dimin-

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ished the area of contact between the boot and the floor. Dr. Davis was perfectly right in saying that a certain amount of building-up could be done inside of the boot; but this simply shortens the lever, and to that extent renders it less efficient. The difficulty could be overcome by adding a brace, as suggested, but he found that most people were very glad to avoid a brace whenever possible. It is true that the foot has a tendency to turn inside of the boot, and in the cases of severe deformity of equino-varus or equino-valgus it would be very much twisted out of shape; at the same time, it seemed to him that it undoubtedly gave some assistance in holding up the foot in proper position. He had actually created cases of serious valgus by the use of this club-foot shoe. The difficulty referred to by Dr. Ketch could only be overcome in some instances by the attachment of some brace to the boot.

Dr. Whitman said that he had called attention to the contraction of the toes that was often present in these cases, and to the importance of overcoming the rigidity of the metatarsal arch and regaining the range of dorsal flexion of the toes, in order to assure a cure.

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A STUDY OF THE SITTING POSTURE AND A PROPOSED APPARATUS FOR PATIENTS SHORTENED BY POTT'S DISEASE.

By A. B. JUDSON, M. D.,
NEW YORK.

I WOULD like to raise the question whether the condition which too often follows Pott's disease cannot be improved by the use of an apparatus for giving the patient greater height when in the sitting position. Devising and improving such an apparatus, as is the case generally with mechanical invention of any kind, would require some experimentation and what may seem to be the waste of considerable time before a useful result is reached. But I believe that a successful application of this kind would be desirable.

Some of these patients have long limbs, and they would be tall men and women were it not for the shortening of the vertebral column. A surprising effect is sometimes produced when such a patient takes a seat, in a car, for instance. The head and shoulders continue to descend until they are considerably below the common level (Fig. 1). In standing the shortening may not be especially noticeable, as it belongs to the whole figure; but in sitting it belongs entirely to the trunk, and the result is one which may well be avoided if it can be done conveniently.

The apparatus which I have in mind should be worn out of sight under the clothes. It should have a frame sufficiently strong and rigid to support the weight of the body. The frame should be so made as to collapse or to be shut up when the wearer rises, and when he sits it should come into action automatically, to keep the body at a reasonable distance from the seat of the chair (Fig. 2).

It would seem that such an apparatus should have its bearings not only at the ischiatic tuberosity, but also along the posterior surface of the femoral shaft, as it will be recalled that in sitting we

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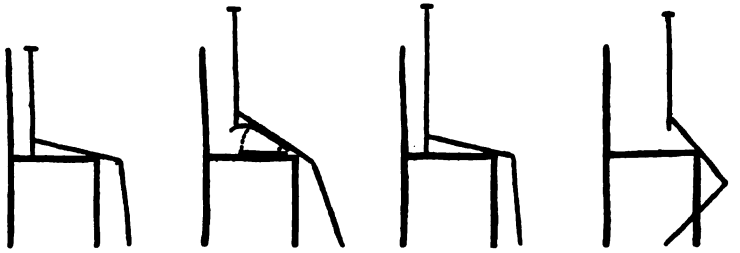
often make use of the thigh-bones as well as the ossa innominata (Fig. 3). When we are tired or in a lounging mood we may sit on the sacrum or, if the feet are on the mantel-piece, on the lumbar region of the spine. An inquisitive European discovered that the Americans were accustomed to sit on the small of the back, and had thus ingeniously demonstrated the use of the part of the anatomy which had been supposed to have no particular function. At other times and in other moods we may sit comfortably on the ischiatic tuberosities alone, and if we would appear erect and dignified we may sit with the tuberosities raised from the seat and with the weight of the body borne by the femoral shafts resting on the edge of the chair. In this last position the natural height is at its

FIG. 1. FIG. 2. FIG. 3. FIG. 4.



best, and patients shortened by Pott's disease may be observed to sit in this manner (Fig. 4) until fatigue prompts a more easy attitude with a descent of the head and shoulders (Fig. 1), which in some cases may, in all probability, be prevented by the use of the apparatus suggested (Fig. 2).

I have nothing further to present on this subject, and close by expressing the hope that some one will carry the idea further.

DISCUSSION.

DR. HENRY LING TAYLOR, of New York, said that the idea proposed by Dr. Judson was new to him in that connection. He had himself used a hair-cushion strapped to the body or clothing on the atrophied side of paralytic cases. A wider cushion, covering both ischia, might increase the sitting height without being noticeable.

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A BRACE FOR CERVICAL SPONDYLITIS.

By WALLACE BLANCHARD, M.D.,
CHICAGO.

The brace which I have the honor to offer for your inspection is presented as embodying certain therapeutic requirements in the treatment of cervical spondylitis. If it be admitted of this, as perhaps it might be admitted of all other destructive tubercular diseases of movable articulations, that it is friction that grinds down the inflamed osseous structure into detritus and destroys reparative tissue more rapidly than it can be produced, then it necessarily follows that the rational treatment must be that which relieves both movement and pressure, the two factors of friction, to the best possible advantage.

To relieve pressure on the cervical vertebral bodies to the best advantage, it is undoubtedly necessary to carry the head backward so as to make the spinous processes divide, with any apparatus that may be used, the superincumbent weight of the head, and for purposes of treatment at least the first seven dorsal vertebræ must be classed with the cervical.

This brace is built with the following objects in view: to as nearly as possible immobilize the head and neck, to transfer as far as may be possible the weight of the head directly to the pelvic portion of the body, to carry the head backward so as to impose upon the spinous processes all of the weight that may not be taken by the brace, and to protect the diseased bodies of the vertebræ from jar and concussion.

The brace is made by supporting a large pad, shaped into an occipital socket in which the head, when held by a strap passing around over the forehead, will rest immovably. This occipital pad rests on an arch formed by the joining of two steel straps passed down over the posterior face of a leather shell-back brace, and these

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are there secured in such a manner as to be raised or lowered to any desired position, and there held by set-screws.

The accuracy with which the leather shell-back brace fits every outline of the body makes it a nearly immovable foundation.

FIG. 1.

Brace for cervical spondylitis partially applied, with the chin nearly touching the chest, which is the typical position in advanced cervical spondylitis.

In applying the brace the leather shell-back should be securely laced and strapped to the body, and the occipital pad should then be in a position so far posterior to and above a level with the occiput that considerable force shall be required in lifting and carrying back-

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ward the head so as to place the occiput on the pad, and with the chin somewhat elevated; then buckle the strap over the forehead, and the head will be securely held in place. Fig. 1 shows the brace partially applied, with the head forward and chin nearly touching the

FIG. 2.

Brace for cervical spondylitis applied.

chest, which is the typical position in advanced cervical spondylitis, while Fig. 2 shows the head in the corrected position, as held when the brace has been securely applied, with the occipital pad serving as a fulcrum on which to lift the head.

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With the several chin-supporting braces in use the head is thrown backward and upward every time the patient opens his mouth in the acts of speaking and mastication, while few of these forms of apparatus impede in any manner whatever lateral rotation. The Sayre jury-mast has no retarding effect whatever on rotation; neither does it make any attempt to carry the head backward so as to transfer a portion of the weight to the transverse processes. The wearing of each of these forms of apparatus that depend on chin straps or chin pads is frequently seen to result in flattened jaws, giving a fish-mouth appearance to the patient's face, and even more frequently they are seen to interfere with dentition.

The brace which I am offering for your kind consideration not only obviates these distressing disadvantages, but the patient may also be able, with cap and coat, to walk the streets without attracting attention to the fact that he is wearing any sort of mechanical appliance.

In all the cases in my charge wearing this brace it is never removed night or day except for bathing and change of underwear.

I have used this brace for quite a number of years with what I believe to be very marked success, and the cases, though my records are not complete, are upward of a hundred, besides quite a number of surgeons in the Northwest have followed my lead for a number of years in the same plan of treatment.

My first paper on this method of treating cervical spondylitis was published in the April, 1878, number of the *Chicago Medical Journal and Examiner*.

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ORTHOPEDIC APPLIANCE SHOP.

By LEMUEL F. WOODWARD, M.D.,
WORCESTER, MASS.

Last winter your President invited me to read at this meeting, and I suggested a topic that was of interest to me at the time. His reply was, "We do not want that. Tell us about an orthopedic appliance shop." And so I appear before you now with no other excuse than the President's command. Still it does seem presumptuous for me to present this topic to you, who have such splendidly equipped workshops, and I shall only talk to the few who are still trying to find out the best way to get orthopedic work done.

I feel that the topic is an important one, because our success in a given case depends not only on our diagnosis and persistent treatment, but upon the way the treatment is carried out by the child's nurse or mother, and it is asking too much of any parent to insist on a child's wearing a poorly constructed and uncomfortable brace.

The mechanical end of orthopedics was not taught in the schools in my day, and when I passed out from under Dr. Bradford's fostering care I felt equal to grappling with any deformity, but was promptly floored when I attempted to get the blacksmith who repaired my father's carriages to make a Taylor back brace. The brace fitted well enough, but the child's mother after lifting it said: "Doctor, I do not think the baby is strong enough to carry that splint. It weighs almost as much as she does."

The problem to the young orthopedic surgeon just starting in a new region is particularly trying. We have on the one hand the surgeon without any knowledge of mechanics, and on the other the mechanic without any knowledge of surgery. Now, it is out of the question to teach the mechanic surgery, and the doctor must of necessity learn something about mechanics.

In my own case I started my first shop in my own house, and,

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with the help of an intelligent Swede, did much of the work myself, and really learned considerable about iron and steel and as to how the work ought to be done.

The chief difficulty in starting a shop is in finding a suitable man. The work is unlike any class of work that comes into the machine shops, for there are no set patterns to follow, and even the drawings the doctor sometimes makes are rough, crude, and inaccurate. As the patient is never seen by the mechanic, he really has but little idea what he is doing, and as no two cases are exactly alike, he cannot have any idea as to standard shapes and sizes. And it is surprising that this combination of an unmechanical surgeon and an unsurgical mechanic should get good work out as often as it does.

At the outset the beginner in orthopedics has his choice of two methods of getting his braces made. He can either make arrangements to have it done in some "jobbing shop," or start a shop of his own. In the large cities the latter is, without doubt, the only satisfactory way, but in the smaller places it is difficult to find steady work enough to keep such a shop going.

Some ten years ago the Memorial Hospital was built, and soon after we equipped an appliance shop and ran it for some time. We found that, with the limited quantity of work which came to us, the expense of each brace was greatly increased over the contract method, but that there was a saving to the hospital in the time required in getting work done. On the side of convenience there is no question, and the same workman will make his braces in better proportions if he can see the patient and assist in the measurements. With our shop we can experiment to any extent at small expense, but against all these advantages comes the vulgar but powerful argument of expense. And a shop is of necessity an expensive luxury, and can only be run at a profit where there is a great quantity of work done every month.

We tried the experiment of hiring a mechanic who was a good engineer and could take care of the boilers and work on the grounds at leisure moments, with the result of demoralizing both the shop and the hospital help, and I am convinced that the shop force cannot be used for any other sort of work about a hospital.

The first requisite in equipping a shop is a good mechanic. No great skill in blacksmithing is required, as most of the work can be

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done with the simplest forgings, but the man must be expert with the bench tools, and a good hand with the lathe, drill, and grinder. He must be bright enough to follow blind directions, and good-tempered over mistakes. Such a man, with us, can be hired for about $3 a day.

Beside the mechanic it is necessary to have a trimmer, and we have found him much easier to obtain. Almost any harness-maker can be taught to pad splints, as the work is similar to that done in their regular trade. A very good man can be had for from $2 to $2.50 per day. The rest of the help in the shop, if more is needed, can be cheap labor.

The equipments of the shop, outside of your power-plant, should consist of a forge, a lathe, an upright drill, a shear, and an emery-grinder. It is possible to use the lathe for drilling and grinding, but not economical to do so. The lathe should have a four-foot bed and a ten or twelve-inch swing. It can be bought new for $150 to $200, or second-hand for less. The grinder and counter-shaft cost from $20 to $50, without the emery-wheels and belts. The shear works by hand and can be bought for from $20 to $30. A hand or power-forge large enough for our work can be bought for $25 to $50. An upright drill is more convenient than a lathe for drilling, and it can be speeded higher, and it works horizontally instead of vertically. $50 is a fair price for one. The bench-vise and bench and pipe tools cost from $20 to $100.

The cost of equipment, outside the power plant, will be $300 for a minimum, and the maximum is only limited by the appropriation. A power plant is not absolutely essential, as all work is so light that the machines can be run by hand or foot power. But it is the labor that costs in orthopedic work, and anything that is saved here pays in the end.

In my first experiments in brace manufacture I had difficulty in getting the right quality of metal. Spring steel is light, but cannot be worked cold, and no one but an expert can handle it in the fire. It is too elastic for most braces, and is troublesome by breaking if subjected to unusual strains. Iron, on the other hand, is heavy as compared with steel of the same strength, and has but little elasticity, so that, if once bent, it stays there, and ceases to act as a corrective for the deformity.

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We use for most of our work a low grade of steel, known to the trade as machinery steel, soft steel, or cold-rolled steel. It is made by either the Bessemer or the open-hearth process, and comes in sheets, bars, or rods of almost any length, breadth, and thickness. A convenient way to designate the size wanted is to have small samples of common sizes on a ring.

Our blacksmith prefers sheet steel for much of his work, and cuts strips of any width and thickness with his shears, where only short lengths are needed.

This steel can be worked cold, like iron, but has elasticity enough to come back to its original curves after anything but an extreme bend. Soft iron is convenient for connecting strips, as it can be bent after the padding has been put on. Occasionally spring steel is desirable, and can be obtained in sheets or bars similar to the soft steel. The expense of steel of all the common grades is from one to three cents a pound.

Phosphor-bronze and spring brass for flat-foot braces come in sheets varying in thickness; the former costs sixty cents a pound, the latter fifteen cents. The brass can be used for children, but is harder to work, and will break. The bronze rarely breaks. Ordinarily, we do not aim for a high finish, but send our braces out simply polished or oiled, as they are much less conspicuous than when nickeled, and very much less expensive. Now, while we do not at present run a shop, I still thoroughly believe in one, and look forward to the time when we shall have work enough to keep it going. We are able to dispense with it now because our surroundings are exceptional. Our city is noted for its mechanics, and there are numerous small "jobbing shops," so called, where the very best machinists are employed and where the proprietors work with their men. Our arrangement with such a shop is as follows: A particular man is reserved for our work, and all the directions are given directly to him. When we have no work in the shop he is employed as the proprietor sees fit. We pay the shop forty cents an hour for the actual time a man spends on a given brace, beside the cost of material. Our splints are trimmed and padded at the harness-maker's shop, and the arrangement for padding is similar to that with the machinist—that is, forty cents for the work and the cost of material. All orders are sent in on a printed tag.

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The diagram and directions for the blacksmith are written on the back; the spaces on the front are as follows: Date; name; when ordered; by whom ordered; expense of splint; expense of padding; additional expenses; remarks; signed; matron.

This tag comes back with the splint, and constitutes the charge to the patient, and is filed away as a voucher for the mechanic's and trimmer's bill, as well as a memorandum in the case.

We have found that, with several surgeons on duty, it was advisable to have all expenditures and collections controlled by one person, and no order is valid unless signed by the hospital superintendent, and she determines the price that the patient shall pay for the splint and collects the pay. Of course, the hospital is responsible for the payment of the blacksmith's and trimmer's bills, and their accounts are only with the hospital.

Ordinarily, at the dispensary a small profit is charged on all apparatus, and any surplus so obtained is used as a splint fund for poor patients.

I do not know how our prices compare with those of other hospitals, but I will quote a few items as taken from our splint-book.

Taylor hip splint with ratchet, $5.00. Padding, $1.50. Shoe, .50. Total, $7.00.

Thomas knee splint, $3.00. Padding, $1.50. Shoe, .50. Total, $5.00.

Taylor back braces, $2.80 to $6.00.

Bowlegs, $3.70 to $5.00.

Taylor club-foot shoes, $4.00 to $10.00.

Flat-foot plates, $1.00 to $2.00 each.

To conclude, we have tried both plans for getting orthopedic work done, and each has its good points. A well-equipped shop, with an intelligent man at its head, is something that we all desire; but I am convinced that it can be made self-supporting only in the large cities. In the smaller places it is more economical to contract the work out to a machine jobbing shop on a basis similar to the one which I have described, if there be one in the immediate neighborhood of the hospital.

Gentlemen, I thank you for listening to me on this necessary though uninteresting subject, and I will take refuge again for bringing it before you behind your President's orders.

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DISCUSSION.

DR. COOK said that he had had a very similar experience, having tried the plan of having a partial shop at the hospital. It had failed, for a number of reasons. At present he had an arrangement with a jobbing shop, similar to the one described in the paper, and the work was quite creditable. He had found it a great advantage to have the man who makes the apparatus see the patient. His arrangement was such that the man could be at the surgeon's disposal for several hours a week at his office. The patient is measured at one time, at a second visit the brace is fitted, and at the third visit the final fitting is done. What is called "tool steel" is used by his workmen, and the braces are all covered in a harness shop. The bills from the harness shop constitute the larger part of the item of cost. His workmen had been under his direction for about ten years now. It did not seem to him practicable for a country surgeon to send to the cities for his apparatus; the patient must be seen and fitted in the presence of the workman.

DR. ARTHUR J. GILLETTE said that he could not see any use in having the instrument-maker around; his instrument-maker never sees the cases, because if he does he thinks he knows more about them than the surgeon, and will not follow directions. If the measurements were correct, and the steel properly made, he could fit and adjust the apparatus himself better without the assistance of the instrument-maker.

DR. NEWTON M. SHAFFER, of New York, said that in 1882 and subsequently, in his lectures before the University Medical College, he had taught on the same lines sketched in the paper just presented. At that time he had insisted upon the necessity of the surgeon being the absolute master of the situation, and of not allowing the instrument-maker to come in contact with the patient at all. The surgeon should be absolutely responsible for every detail of the work, taking his own measurements and fitting the apparatus. At the New York Orthopedic Hospital, where there was an exceedingly complete shop, the directions for a brace are considered in the light

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of a prescription from a physician—the surgeon doing everything in the way of fitting, etc., the instrument-maker being responsible only for the crude mechanical work.

DR. F. E. PECKHAM said that he had one man who did both the leather and the metal work. He buys his own material and gets his own profit out of the completed production, thus leaving the surgeon free from the responsibility of purchasing material. The instrument-maker does not see the patient at all.

DR. COOK said that perhaps he had not made himself entirely clear. He agreed entirely with Dr. Shaffer that the surgeon must be wholly responsible for the measurements and for the brace. His patient comes to his office and the instrument-maker is shown the condition, and the surgeon helps to draw the diagram, while the instrument-maker takes the measurements. At the next visit the brace is in the rough, and is fitted by the surgeon. At the last visit the instrument-maker makes the final changes in the apparatus, under the surgeon's supervision.

DR. WOODWARD said that he had been totally unable to teach any one else, even the house officers, to take the measurements and fit the braces his way. The mechanics could not do this, although they would do the work well from the measurements of the surgeon.

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THE CORRECTION OF SPINAL DEFORMITY BY STAGES, UNDER AN ANÆSTHETIC.

By V. P. GIBNEY, M.D,
NEW YORK.

The presentation of a paper which must necessarily be incomplete is, of course, to be deprecated. The great interest, however, in the subject prompts me to make this preliminary report in order to record my own observations in the immediate correction of the deformity after Pott's disease and also in that of lateral curvature of the spine. A brief paper has already been published by the author in the *New York Medical Journal* in March of the present year. A few of the cases are already on record in the aforesaid journal, but, inasmuch as I have had the opportunity of observing the patients since—indeed, as they are still under observation—I am simply here to-day to report progress.

The exact records or tracings I shall not reproduce, as I have not removed the corsets or the jackets in all instances for this tracing, and because, too, the cases themselves are incomplete.

It is my intention to disabuse your mind, as my own has been disabused, of certain erroneous impressions and certain dangers which have been suggested by writers upon this subject. At the same time, I do not desire to give the impression that the operation itself is entirely free from danger. The patient, for instance, may take ether poorly; too much force may be employed at the first operation; the disease itself may be located in a rather dangerous part of the spinal column; the personal element of the patient may be a contraindication. Yet I am convinced that, with reasonable care, such as orthopedic surgeons are in the habit of employing in their work, the deformity may be corrected by repeating the procedure, say, half a dozen times. Again, a certain amount of correction may

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be secured without the use of an anæsthetic, by rather frequent renewal of the plaster-of-Paris or whatever dressing may be employed. Especially is this desirable where one is not thoroughly conversant with the use of plaster-of-Paris. Even in the best of hands excoriations may sometimes occur, but excoriations occurring in cases like those now under discussion necessarily bring discredit upon the treatment. We somehow feel that we are able to maintain a good position when once secured. In England, where plaster has for a long time been tabooed, cumbersome appliances are employed, though such appliances are generally managed or controlled by skilful men. On the Continent, plaster-of-Paris with an immense amount of cotton-batting is employed about the body, and it does seem to me that the deformity is bound to recur where so much cotton is employed. The ideal dressing would be, of course, a skin-fitting plaster-of-Paris bandage, secured accurately about all the salient points. In this country most of us are reasonably familiar with the use of plaster, and we take certain precautions that will guard against excoriation. It may just as well be stated now that excoriations are not the worst things a patient can have; that even if a small ulcer is produced over the tip of the boss, or a long one at the side of it, there is no real damage done to the disease itself. The only trouble is that we are obliged to discontinue the fixation, during which period the deformity is apt to recur. In my own cases I have not seen fit to include the head in the dressing. I have employed piano felting on either side of the boss, over the iliac crests, along the free ribs, where these protrude, and have bound these on with a cheese-cloth bandage, after having secured more firmly these pads by means of a needle and thread. With such precautions I find rarely, if ever, any excoriation, and I want to put this on record, although I am unprepared, as above mentioned, to give final results so far as deformity goes.

In reapplying plaster, where an anæsthetic is not employed, I have been in the habit recently of hyperextending the column and the hips, thus securing a very decided recession of the deformity. At the time I began this work I was under the impression that the method had not been employed in the city of New York. I find since, however, that, while this is true, it has been employed in Chicago, at least. The cases are as follows:

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CASE I. A boy, aged twelve years, in very good general condition, but with a very awkward gait and a deformity in the dorso-lumbar region, resulting from old Pott's disease, many years having elapsed since acute symptoms prevailed. The tracing was taken before force was employed, and a very thorough examination was made in the iliac fossæ in search of the psoas abscess, with negative results. It was difficult, however, to fully extend the thighs. Under an anæsthetic, which was gas and ether, and with the assistance of the house staff, I operated March 1, 1898. By making firm pressure over the boss I succeeded in breaking down the deformity, and the tracing showed very nearly a straight line. There was an immense amount of crackling, the result of the breaking up of bony and ligamentous adhesions. On removing the pressure, however, there was a little recurrence, but on applying the jacket I felt quite sure that the good position would be maintained. Following the instructions of Calot and others, I put the patient to bed, intending to keep him there for the next two or three weeks. The next morning he was ready to sit up; in fact, felt no pain whatever, and, strange to say, had passed a very good night without a narcotic. After three or four days he was allowed to get up, there being no apparent reason for longer bed treatment. At the end of a fortnight we removed the jacket, in order to reapply, without an anæsthetic, and found a good-sized psoas abscess in the iliac fossa. A large needle was inserted, but it was a dry tap. I applied plaster again, and a week or two later, under an anæsthetic, employed more force, maintaining this good position ever since. The abscess has given no trouble, and I doubt very much whether it will. If it does, I am prepared to take care of this complication.

CASE II. A male, aged five years; deformity, Pott's disease; mid-dorsal. This boy had been in the hospital for a long time, had worn solid plaster-of-Paris jackets, and was quite accustomed to them. Examination, made February 17, 1898, showed that his urine was normal; there was no pain or tenderness on pressure, and no sign of any abscess. The disease was not active. On March 8th, under ether, manual force was employed over the boss, and the characteristic crackling was both felt and heard. While making pressure his respiration became affected a little, and the ether was

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discontinued for one or two minutes; then, as danger seemed to have passed, it was renewed. The deformity in this case was not completely overcome. I should say it was about two-thirds overcome. He was put in plaster, with the back hyperextended as much as possible. No unpleasant results followed. He was kept in bed for about two weeks; then, on April 20, 1898, the jacket was cut down. There were no excoriations, except in one or two places on the side of his body, where he had dropped some buttons. He was put in a swing at this time, and an attempt made to correct. This was, in a measure, successful. It has been rather difficult to keep his shoulders back, although the plaster extended thereover, and at present writing I doubt very much whether the good position maintained at the time of the first operation remains. We expect to send him to the country for the summer, and in the fall the efforts at correction will be renewed.

CASE III. *Partial paralysis, due to compression, promptly relieved; death from scarlet fever; no autopsy.* A male, aged ten years, from the country, was admitted April 5, 1898. There was incomplete paralysis of the lower extremities. On the right side it was nearly complete. The reflexes were exaggerated. There was no impairment of sensation. The deformity had existed, so far as history goes, about two months only, the loss of power two or three weeks. The boss was located in the upper dorsal. Two days after admission he was put under ether, and an attempt made to reduce the deformity. It was only about one-half reduced. The plaster was carried well up around the neck and over the shoulders, and the dorso-lumbar spine was put up in hyperextension. The following day there was a decided improvement in his limbs. He was able to move them about in bed quite freely, and he seemed anxious to stand up; was kept in bed, however, and especial care taken to avoid sitting up. On the third day he showed a rather high temperature, and next morning it was found that scarlet fever had developed. He was taken at once to the Willard Parker Hospital, where he died in forty-eight hours. No autopsy was allowed.

CASE IV. A girl, aged ten years, presented a deformity in the mid-dorsal, the result of Pott's disease of long standing. There had

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been no acute symptoms for two years. On May 3, 1898, the spine was forcibly stretched and a plaster-of-Paris jacket applied. This child was rather nervous. Mother said that she had had for a long time peculiar symptoms, such as spasm and pain, without any special cause, and that these attacks would pass off within a day or two. This child was not allowed to get out of bed for three or four weeks. At this time the plaster-of-Paris was removed, further correction was made without an anæsthetic, and this treatment will be continued until we secure a complete recession of the deformity.

CASE V. A boy, aged six years, who gave a history of rickets. The deformity appeared some three years prior to this time, and he was brought to the hospital a year later. The deformity was thought to be rhachitic. On further examination, at the time of his admission, April 15, 1898, deformity could not be corrected by manual force without an anæsthetic, and there was a history of pains, pointing toward the disease being tuberculous. He was put under gas and ether on April 20th, and direct pressure made over the boss. The deformity was reduced at least one-half. Since then, without an anæsthetic, it has been reduced still more, and he is at present under treatment.

These include all the cases of Pott's disease, and in the following cases of lateral curvature, I am free to confess, results are far from brilliant. I am satisfied with the treatment thus far, yet it is a very laborious process. One gains very little at each operation, and consequently gets discouraged. Inasmuch as the cases subjected to this are extreme, as a rule, and inasmuch as the apparatus and exercises fail to effect any decidedly good results, I feel that it is our duty to resort to almost any procedure provided it is attended with little danger.

CASE VI. An Italian girl, aged fourteen years, had at the time of her admission to the hospital, in December, 1897, a very marked rotary lateral curvature, dorsal. This deformity had stunted her growth, given her a peculiar hunchback, and it was, as our English brethren say, "osseous;" that is to say, we could effect no improvement by suspension. On January 4, 1898, I attempted to stretch

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the back in an apparatus specially constructed for the purpose, and employed the Schleich mixture for anæsthetic. The patient got too much chloroform, and we had to desist. I question very much whether any reduction of the deformity was gained at this time. In March I made two or three attempts under an anæsthetic, and secured from two to three inches increase in height. I have been careful to maintain this improvement by renewing the jackets frequently while she was suspended in the swing. Certainly at this time there is some flexibility in the column, and I am encouraged to proceed further with the treatment.

CASE VII. A girl, aged six years, who presented a right rotary lateral curvature, rather rigid and unyielding. On March 22d the spine was forcibly stretched and a fair amount of rotation obtained. On March 24th she was again put under an anæsthetic, and once or twice the plaster has been renewed. She has since then been wearing a solid plaster-of-Paris jacket, has been suffering from no excoriations, and there is a distinct gain in height.

CASE VIII. A girl, nine years of age, "letter-S" curvature, rhachitic in origin. She has been under treatment for a number of years at the hospital, without material change. On March 21st, under ether, I succeeded in reducing the deformity about one-half. She is wearing plaster-of-Paris now. The plaster has been renewed once or twice, and the treatment is to be continued.

Such is my experience, and I intend to take up the work again during the coming fall and winter. There have been a certain number of bad results in reported cases from the other side of the water; none, I believe, on this side. It is well to bear in mind that any good thing can be abused. At the same time, we should remember that the special deformities which are now under discussion are most obstinate.

This treatment will be employed in selected cases; contraindications will be the better understood as the result of our recorded experience, and, in the mean time, it is safe to assert that very few, if any, casualties will result—at least they ought not to result—if surgeons will resist the temptation to effect complete obliteration of the deformity at one operation.

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THE IMMEDIATE CORRECTION OF THE DEFORMITIES RESULTING FROM POTT'S DISEASE.

By JOEL E. GOLDTHWAIT, M.D.,
BOSTON.

UNTIL recently the essential part of the treatment of Pott's disease or caries of the spine consisted in fixation of the spinal column. No attempt at the reduction of the existing deformity was made, the desire being to relieve the irritation as much as possible by means of the fixation, and to prevent an increase in the projection of the bones. To accomplish this result various forms of apparatus have been devised and various methods of treatment have been suggested, but with all, while occasionally no further increase has shown, and even in rare instances while a diminution in the projection has resulted, still, in the large majority of cases, in spite of the most careful attention and without regard to the method of treatment, the deformity has increased. The presence of this deformity has been considered a necessary part of the disease, and if it has been possible to carry the patient through to convalescence with only a moderate increase of the deformity the result has been considered satisfactory.

In 1890 Dr. Hadra, of Galveston, Tex., presented a paper at the meeting of the American Orthopedic Association in which he reported a case of fracture of the low cervical spine in which he had corrected the position of the head and maintained the position by wiring the spinous process of the cervical vertebræ. He also advocated this procedure in spinal caries, but reported no cases.

In 1895 Chipault reported a series of cases of Pott's disease in which the deformity was forcibly reduced with the patient under the influence of an anæsthetic, and not only were the spinous processes wired, but the transverse processes as well.

In 1896 Calot presented a paper at the Paris Academy of Medi-

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cine, reporting a series of cases in which the deformity was forcibly reduced, and as a part of the procedure, in some of the cases, the spinous processes were excised.

Since then both of these writers have made other contributions, reporting large numbers of cases, and with both, in the later writings, the cutting part of the operation has been practically given up, the whole procedure consisting of the forcible reduction of the deformity by means of traction and pressure over the prominence.

Since the appearance of the first communication from these two writers numerous other surgeons, chiefly on the Continent, have reported cases of a similar nature, and while in some of the early cases incision was resorted to with removal of or wiring of the spinous processes, the majority of the operations have consisted simply in forcibly straightening the spine.

The after-treatment in common use consists in the application of a plaster-of-Paris dressing, in which the whole body and head is included, and this is worn without changing for six months.

While for practical purposes the operation performed by Chipault and Calot is new, it is not, however, the first time that spinal deformities have been forcibly reduced. The history of medicine shows that at different periods a similar procedure has been practised by different surgeons, and it is not improbable that in days, generations or centuries ago, when reports and records of cases were not as carefully made or as common as now, the immediate reduction of the spinal deformities was not a rare operation. Hippocrates, writing five hundred years before Christ, speaks of the procedure as an old one, and reports several different methods for accomplishing the result.

One, which is termed Succussion, as described in the Adams translation, Sydenham edition, and in Bigg's *Orthopraxy*, consisted in putting the patient on an ordinary ladder and securely fastening the hips and legs, leaving the upper part of the body free. The ladder with the patient, feet uppermost, was then drawn up to a "tower, or the mast of a ship," and dropped. Before reaching the ground the fall was suddenly stopped, and in this way, with the head downward and the lower part of the body fastened to the ladder, the upper part, which was unattached, jerked the vertebræ apart and corrected the deformity.

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Another method, also ascribed to Hippocrates and described in Bigg's *Orthopraxy*, is more suggestive of a surgical operation, and it should be said also that this is the method which was preferred by Hippocrates for "gibbosities," as the disease was then termed.

"Something like an oaken bench, of a quadrangular shape, is to be laid along at a distance from the wall (in which there had previously been scooped an oblong furrow), which will admit of persons passing around, if necessary, and the bench is to be covered with robes, or anything else which is soft, but does not yield much. The patient, after being stoved and bathed with hot water, is to be stretched upon the board upon his face, the arms being laid along and bound to the body. Next the middle of a thong, which is soft, sufficiently broad and long, and composed of two cross-straps of leather, is to be carried along across the patient's breast, as near the armpits as possible; then what is over the thongs at the armpits is to be carried around the shoulders, and afterward the ends of the thong are to be fastened to a piece of wood resembling a pestle; they are to be adapted to the length of the bench below the patient, and so that the pestle-like piece of wood resting against this bench may make extension. Another such bond is applied about the knees and the ankles, and the ends of the thong fastened to a similar piece of wood, and another thong, broad, soft, and strong, in the form of a swathe, having breadth and length sufficient, is to be bound tightly about the loins, as near the hips as possible; and then what remains of the swathe-like thong with the ends of the thongs must be fastened to the piece of wood at the patient's feet, and extension in this fashion is made upward and downward equally and at the same time in a straight line."

Still another method, as described by Jones, and also attributed to Hippocrates, is as follows: "The patient being laid on his back, a leather bottle, not inflated, was laid under the deformity and blown up by an assistant with a forge-bellows." This particular method, as might be expected, is described as not being successful.

Ambrose Paré, writing in 1647, in an article entitled "How to Restore the Spine Outwardly Dislocated," describes a method which is surprisingly similar to that followed by Calot and the French school at the present time. His method is as follows: "The vertebræ outwardly dislocated, when as they stand bunching forth, then

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is it fit to lay and stretch forth the patient upon a table, with his face downward, and straightly bind him about with towels under the armpits and about the flanks and thighs; and then to draw and extend as much as we can upward and downward, yet without violence." It also states that if traction is not sufficient two pieces of wood are to be cut out and, when padded, are to be applied over the spine, and the correction made by pressing down on these with the hands.

Other writers speak of the procedure. Joerg accomplished the result by continued traction in bed, with pressure over the hump.

However much the operation may have been performed in the distant past, certain it is that for many years or generations the treatment has consisted in fixation of the spine in the deformed position and in limiting the development of the deformity as much as possible. Braces have been devised which have attempted the reduction of the deformity; but very little, if any, improvement has been accomplished in this way, and anything like forcible correction has been carefully avoided. To Chipault and Calot must be given the credit of this present radical departure from the conservative methods which have so long been in use. In the past, at different periods separated by many centuries, a similar operation has been performed, but for reasons which, unfortunately, the historians do not supply, each time the operation has been given up, to be revived centuries later, and then, after a brief trial, to be again forgotten. At this time it would be particularly interesting if the reasons could be known why the method has so many times dropped into disuse, and one can but wonder if another generation will find the immediate reduction of such deformities a matter of history. Certainly, if we are to expect all that has been claimed by the writers who have written the most, and have advocated the method most strongly, our disappointment will be keen, and but a short time will be necessary for the whole procedure to be discarded. Few surgeons familiar with the disease are willing to believe that the correction of humpback, which is merely a symptom of Pott's disease, and a plaster-of-Paris jacket worn for six months will make the patient well. If, however, the method is to be accepted as one part of the treatment of Pott's disease, to be used in selected cases, as other methods are used, this, together with our more perfect knowledge of mechanical

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therapeutics, makes it seem probable that much good will follow, and that in a certain number of cases the existing deformity will actually be diminished, and that in most of the early cases the increase will be less than has formerly been the case.

The exact operation, as commonly performed, both in England and on the Continent, is described by Jones[1] as follows:

"Having determined to forcibly reduce the deformity in a case of Pott's disease, it is necessary to carefully prepare our patient, more especially if the plaster corset recommended by Calot be applied. For two or three days previously the patient should be dieted with a view to supplying nourishment and avoiding waste concretions. The bowels should be thoroughly well opened, so that, if necessary, abdominal pressure may be applied by the hand without risk; and, for the same reason, the bladder should be empty. It is hardly necessary to state that the skin should be deodorized and disinfected, and that the head should be shaved. In order to avoid insect life, the scalp should be treated for a sufficient time. An assistant should now prepare the traction bandage. This consists of two linen bands a yard long. The centre of one piece is placed around the occiput, the centre of the other around the chin. They meet beneath the ear on each side, and at this point are firmly fixed by safety-pins. The free ends are knotted, and an assistant takes a loop in each hand, or, more conveniently still, the loops may be attached to a crossbar of wood or other material. The linen bands must be of equal length, otherwise the head is not pulled in line with the spine. They should be fully a yard long, in order that the assistant who controls the head may be well out of the way of the anæsthetist. This traction is quite essential, as one cannot act upon the spine by manual grasp upon the head for any length of time. In addition to the assistant who controls the head, six others are needed: two for the arms, two for the legs, one for chloroform, and one to directly assist the operating surgeon. Chloroform having been administered, at a given signal traction must be exercised. If the patient be small he need not be supported by chest or pelvic rack. A child of two and a half years requires a pull of 220 kilos. before the neck is dislocated. Traction, therefore, measured if neces-

[1] Robert Jones. The Immediate Obliteration of Deformity in Pott's Disease.

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sary by the dynamometer, should be well within that strength. Roughly speaking, five men, pulling with a force that soon tires, rarely exceed 70 kilos., so that the danger of dislocation is very slight. All, however, should pull together, and there should be no jerk. This applies more especially to the assistant who controls the head. Simple traction will reduce the deformity in a large number of cases, particularly in curvatures situated high up. If it does not, direct pressure must be applied to the hump. An assistant places his hand upon the abdomen with sufficient power to feel the bodies of the vertebræ, and it is to anticipate this pressure that I have advised a careful diet and an empty bowel. This pressure on the vertebræ from the front is a check upon the surgeon who presses directly upon the hump, and who uses sufficient force to reduce the deformity, if he can do so with safety."

Such is the operation as it has been performed. The aggregate number of cases which have been operated upon in this way is quite large, and the immediate results have been surprisingly good, while the cases in which unpleasant complications have developed have been remarkably few when the amount of force used is considered.

My own work upon the subject was commenced this past winter; and at the very outset it was a matter of much surprise that the correction could be accomplished with so much ease in the majority of cases, provided the spine was bent backward at the time traction was made. It was a matter of equal surprise that it was so difficult to maintain the correction, no matter how carefully the after-treatment was managed. The position when the jacket was applied would be satisfactory, but when it was removed the deformity would be almost as bad as ever, even though the jacket retained its shape, and even though it was applied with much less padding than is recommended by Calot, who uses an inch thickness of felt all over the body. This led to much experimentation, and it was soon found that, if the patient was placed upon the back, and all the weight of the body above the thighs was borne upon a small upright which rested directly over the apex of the kyphosis, the spine could be over-extended much more than was possible with suspension or horizontal traction, and that jackets applied in this position gave more satisfactory results.

At first this method was used simply to obtain the best possible

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position of the spine after the forcible straightening under ether, but it was soon found that the same apparatus could be used for the correction, and that in a surprisingly large number of cases no other force than the weight of the body was necessary to straighten and over-extend the spine. With the spine in this over-extended position the head was thrown so far back, and the body weight put so much upon the spinous and transverse processes, that it was possible to discard the helmet as a part of the support, except when the disease was situated above the fourth dorsal vertebra. In nearly all of the cases since the first, the after-treatment has consisted in the application of a plaster-of-Paris jacket carried low enough to grip the pelvis and to limit the motions of the thighs, and also high enough to prevent the shoulders from drooping forward, and the bending forward of the head.

In the early cases ether was used for the correction, but since then the work has been done entirely without anæsthetics except in cases where the disease has been of several years' duration. Cases of one and two years' duration have been easily straightened without ether, and with practically no pain or suffering to the patient.

In this way the operation has been simplified to such an extent that the word operation is hardly necessary for its designation, and it is so simple that in the acute or early stages of the disease the patients are treated in the office or the hospital out-patient department, the correction being accomplished and the jacket applied with no more disturbance than is expected with the application of such an apparatus in the ordinary method. In some of the cases the relief of the existing acute symptoms has been very striking with the improved position of the spine.

The apparatus which has been used for this purpose is pictured in Fig. 1, and consists of a strong gas-pipe frame, six feet long by two feet wide. Suspended from this is a bar (*a*), in the centre of which is a vertical rod (*b*), forked at the top and long enough to reach to the level of the frame. This cross-bar is simply suspended from the frame so that its position can be changed as desired. Below this is another cross-bar (*c*), which rests on the frame and can also be adjusted as to position. Upon this latter piece (*c*) and upon the fork of the rod (*b*) rest two malleable steel bars (*d*), about eighteen inches long. These rest in grooves one inch apart, and should be

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bent to partly conform with the lumbar curve of the spine, after which they are heavily padded with felt and the patient laid upon

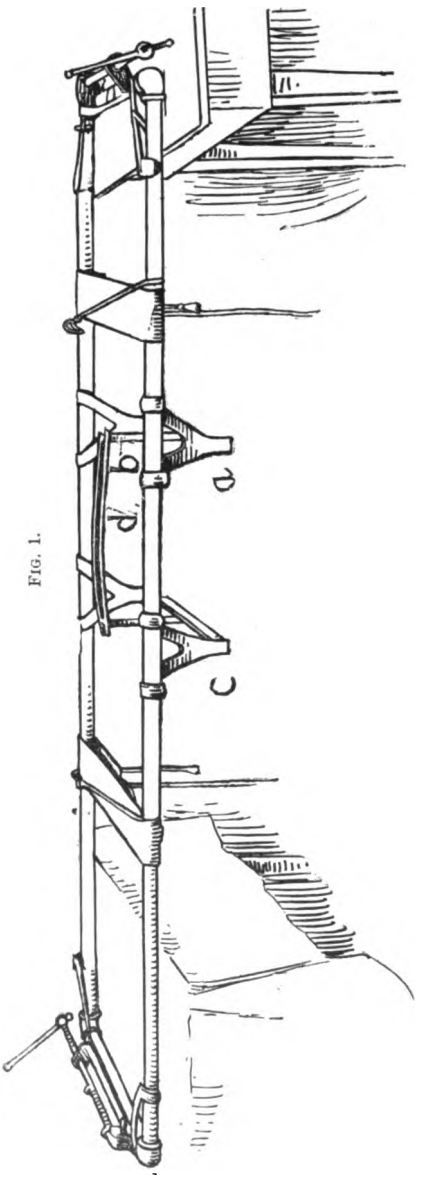
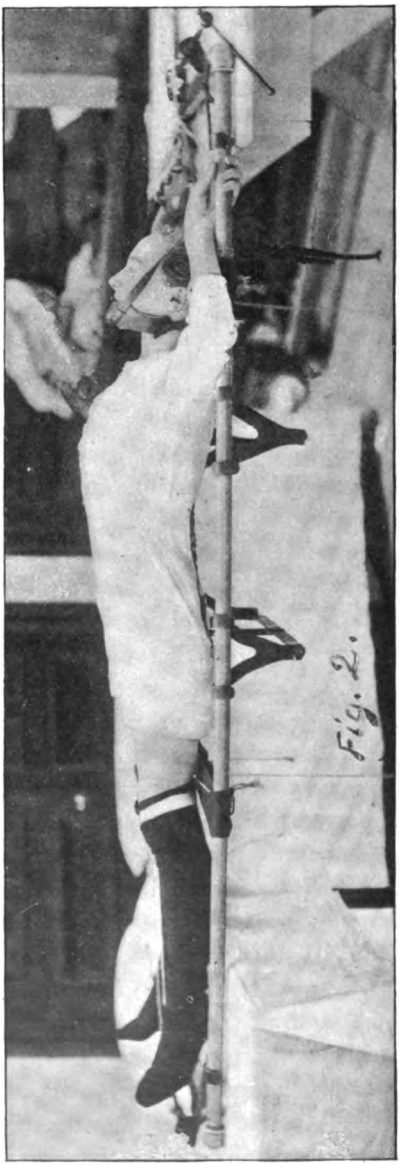


FIG. 1.



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it, as shown in Fig. 2. The upper end of the bars (*d*) should just rest upon the fork (*b*), not projecting over, and when the patient is in position the rod (*b*) should be one inch above the apex of the deformity. The buttocks rest upon the cross-bar (*c*), and the legs are supported by one or more heavy webbing straps which can be tightened or loosened at will. No support whatever is given the upper part of the body, except that the head is steadied by the surgeon with the hand until a satisfactory amount of correction has been accomplished, and then a strap similar to those used below gives the support so that the operator's hand is free. If traction is desirable, it can be applied by means of a windlass which is attached to each end of the frame. This makes it possible to obtain much more definite and steady traction than would be possible with assistants, but its use has not been found necessary in the majority of the cases, simple over-extension of the spine accomplishing the same results.

When the maximum over-extension that is desirable is obtained, the strap under the head is fastened and the patient allowed to lie in this position while the jacket is applied. In applying this the iliac crests should be generously padded with heavy felt, and a similar pad should be placed over the upper part of the sternum, so that the jacket can be carried high up to prevent the upper part of the body with the shoulders from drooping forward. In the cases with disease in the upper dorsal region the jacket should be moulded about the anterior part of the neck so that the erect position of the head is necessary. The forked rod (*b*) is easily avoided by a few figure-of-eight turns of the bandage, so that when the plaster has set the patient can easily be lifted off, and as the rod (*b*) should be placed one inch above the apex of the deformity, this weak spot in the jacket is not objectionable.

When the patient is taken off the frame the two rods (*d*) are slipped out from below, leaving the padding in place.

As a matter of experience, it has been found necessary to practically always cut a small window over the point of greatest deformity, as otherwise when the body settles down, as is inevitable, a slough will form, even though a liberal amount of padding has been used.

With a method so simple it would be unwise to report all of the

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cases in which it has been used, as one case does not differ essentially from another unless there be some special complication. In all, a large number of cases have been treated, and in all in which the disease has not lasted more than a year, both in adults and in children, the correction has been accomplished without ether and without suffering. In some of the cases two or three sittings have been necessary to obtain a satisfactory position, but this is true also of the method used by Calot. In the older cases, or cases of longer duration than one year, many of them have been corrected without an anæsthetic, and while with quite a number ether has been necessary for the first sitting to break up the adhesions, it was not needed at the subsequent treatments, the frame alone being sufficient to accomplish the result.

A few cases reported with some detail may be of interest by way of illustration.

CASE I. A girl, aged five years, was brought to the Children's Hospital in March, 1898, because of a bunch in the back, said to

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have been present for two weeks. The extent of the deformity is shown by the tracing, Fig. 3, *a*. The child was put upon the frame, and just before the jacket was applied the tracing shown in Fig. 3, *b*, was taken. During the whole treatment not a cry or complaint was made by the child.

CASE II. A boy, aged five years, who had a marked knuckle, as is shown in Fig. 4. The child was put upon the frame, and, without ether and without pain, the position shown in Fig. 5 was obtained.

CASE III. A girl, aged eleven years, who had had Pott's disease for three years and had worn a brace for over two years. In Feb-

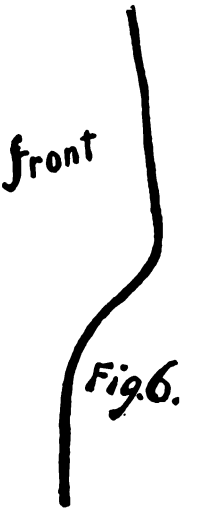

Fig. 6.

ruary of this year the position of the spine was as is shown by the tracing, Fig. 6. When put upon the frame, without ether and without pain, the spine was straightened, as is shown in Fig. 7.

CASE IV. A boy, aged nine years, had had Pott's disease for over three years, with steadily increasing deformity, in spite of care-

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ful mechanical and general treatment. The general condition had been steadily growing worse, and for this reason the correction of the deformity was attempted. The condition just before the operation is shown in Fig. 8. Ether was used for the first correction, but for the subsequent treatments the frame alone has been all that was necessary. The improvement in the child's general condition after the correction has been very striking, due, apparently, very largely to the better opportunity for deep respiration. The con-

Case III.

Case IV., before operation.

dition three weeks after the operation is shown in Fig. 9, and nine weeks from that time, or twelve weeks from the operation, is shown in Fig. 10. The improvement in position between these last two photographs is quite noticeable, and illustrates the gain which can be made from time to time as the jackets are changed. There has been no pain from the first, and the child has been up and about, with the exception of the first two weeks.

As to the age of the patients, most of them, naturally, have been children, the youngest, and this one corrected without ether, being

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four years of age, while the oldest patient was a man of thirty-five. No unpleasant results have been experienced, while in practically all of the cases the symptoms have been relieved, and the paralysis which was present in five of the cases disappeared almost at once.

Case IV., three weeks after operation.

Case IV., twelve weeks after operation.

In one case there was an abscess, which had been discharging for some time. No unpleasant symptoms developed, and the course of the abscess has not been noticeably changed by the treatment. This is given as a contraindication for the operation by some of the writers, yet it does not seem to me that the risk is materially increased, provided there is a free outlet for the discharge. On the other hand, there must always be some risk, and a very considerable risk, especially if much force is used, from the possibility of rupturing a small beginning abscess too deeply seated and too small to be detected by examination.

The effect of the correction upon the paralysis has been most interesting, and in the five cases with this complication the improvement has commenced almost immediately after the spine has been straight-

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ened. Other observers report similar results without much regard to the exact method by which the correction has been accomplished.

This experience would seem to show that, in spite of the varying theories as to the cause of the paralysis, pressure must be the most important element, and that there can be little, if any, degeneration of the nerve-cells or fibres, as restoration of motor control has been at times immediate. In my own cases the improvement occurred at once in two cases, both adults, with whom the correction was performed without ether, the power returning while the patient was upon the frame during the straightening. One of these was particularly striking, and beginning with almost complete loss of motor control of the legs, as well as the bladder and the rectum, as the spine straightened he was able to move the legs. These cases are so striking, and contrast in such a marked way with the results obtained by the ordinary methods of treatment, that a report of the separate cases is offered.

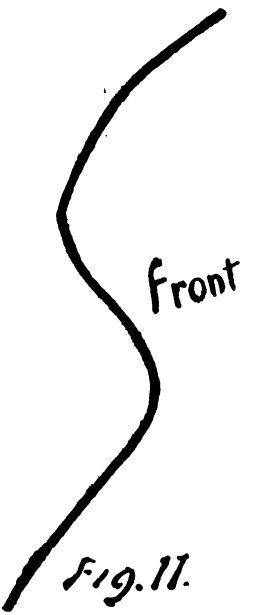

Fig. 11.

CASE I. A young woman, aged twenty years, had had Pott's disease for between three and four years, and, in spite of treatment,

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the deformity had increased to the extent shown in the tracing (Fig. 11). Paraplegia developed nearly two years ago, and after recumbency for one year there was a partial return of power of the legs, and the patient was allowed up, wearing a leather jacket. The improvement continued for two or three months, and then the paralysis returned, so that the bed was again resorted to. The early part of this year the patient was admitted to the Carney Hospital, and under either the spine was straightened and a plaster-of-Paris jacket applied. The next day (the muscles were not tested on the same

day) there was quite perfect voluntary control of the legs. The patient remained in bed for about four weeks, and was then allowed up. Even though the control of the muscles of the legs returned, the exaggeration of the knee reflexes and ankle clonus persisted for two or three months, although this was not marked enough to interfere with walking. This has disappeared, apparently, as the muscular strength has returned. The patient now walks easily, and without other peculiarity to the gait than would be shown by any

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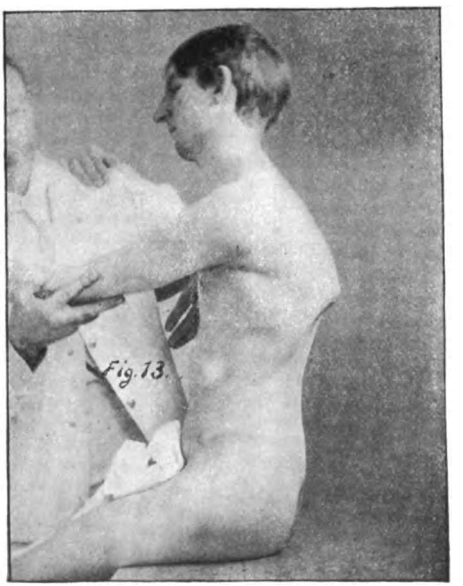
one with whom the spine was held rigid. (Fig. 12 shows the position at the present time.)

CASE II. A man, aged twenty years, was seen first in November, giving a history of spine trouble of five or six months' duration. Paralysis developed after two or three months of treatment, and for this the patient was put to bed, but after two months, there being no improvement, he was admitted to the Carney Hospital. At that time there was not only complete loss of power in both legs, but also paralysis of the bladder and rectum.



Case II., before operation.

Case II., four weeks after operation.

On March 14th, without ether, the spine was straightened upon the frame, and as it straightened the power to move the legs returned. No discomfort whatever was felt by the patient during the treatment, except a momentary sense of suffocation as the straightening commenced. When fully straight, breathing was easier than it had been previously. Since then there has been a gradual improvement in the strength of the legs and in the ability to get about.

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(Fig. 13 was taken just before the operation, and Fig. 14 about four weeks after.)

CASE III. A boy, aged eight years, had disease in the upper lumbar region which had been under treatment for one year. There was only a slight projection of the spine, and during the year there had been practically no increase. In March of this year paralytic symptoms developed in both legs. After a month of bed treatment, during which time there had been no noticeable improvement, the spine was over-extended without ether and a plaster-of-Paris jacket applied. Following this there was very marked improvement, and at the end of two weeks the child was allowed up, and has continued to do well since. The exaggeration of the reflexes has entirely disappeared.

CASE IV. A man, aged twenty-seven years, was first seen in November, 1897, with Pott's disease in the dorsal region, of one and one-half years' duration. At the time of the first examination the knee-jerks were markedly exaggerated and a distinct ankle clonus was present. These symptoms increased so that walking was difficult, and in the following month the patient entered St. Margaret's Hospital, and without ether a correction of the deformity was attempted. The jacket was applied lying on the face on a hammock, and served to hold the spine quite well for a few days, but after that the body seemed to settle into the jacket and the paralysis, which had been relieved, returned. This was repeated for two or three times, each jacket being followed by some improvement, but of short duration.

After this the patient was sent home and kept in bed; in spite of which the paralysis increased, so that there was practically no control of the legs. The bowels were also involved, and dejections were impossible without assistance.

On April 7th the patient was again admitted to the hospital, and by means of the frame, which had been perfected since the first treatment, the spine was straightened, and a jacket applied holding the over-extended position. While on the frame there was a partial return of the voluntary control of the legs, more perfect on the left side. Since then two other jackets have been applied, each being followed by a gain in the use of the legs; so that at the present time

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the patient is able to walk about very easily, and the bowels, for which cathartics had been necessary for several months, have moved regularly without any assistance whatever since the spine was straightened.

CASE V. A man, aged thirty-six years, with dorsal Pott's disease, which had not been recognized until the time of the first examination, in April last. My advice had been asked because of a right-angled deformity of the right knee as the result of an old tumor albus. At this time both legs were paralyzed. The treatment was imperfectly carried out, owing to the fact that the patient lived at a distance from the city and it was necessary to use an improvised apparatus; nevertheless, with the imperfections, a marked gain in motor control of the legs resulted.

The results in these cases are in marked contrast with the results obtained by recumbency, which has until now been the accepted method of treatment.

In Myer's series of 270 cases the average duration of the paralysis, in the cases in which recovery took place, was as follows: in the cervical region, twelve months; in the upper dorsal region, nine and a half months; in the lower dorsal region, six months; and in the lumbar region, eight months.

My own experience has been similar to this series, as the paralysis has been seen in children. In adults the duration has been much longer, and from eighteen months to two years has been more nearly the average time required for recovery.

The immediate results in such a series of cases are so strikingly satisfactory that the ultimate condition of the patients is apt to be overlooked, and in the first enthusiasm over the operation the exact pathology of the disease seems to have been forgotten. Certain it is that the deformity can be reduced in a large number of cases, but the fact remains that the cause of the deformity is the destruction of a considerable portion of one or more vertebræ as the result of tubercular disease. It is also well known that bone repair in this disease takes place much more slowly and less completely than in the other forms of bone disease. Also, it is well known that the reparative process in the bone can take place only after the tubercular granulations have been absorbed, a matter always involving

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many months or years; and what is also an important factor is that, as the bone-forming elements have been so largely destroyed by the disease, the amount of new bone formed must be slight and wholly inadequate to fill the large gap that would be left after the treatment in the severe cases. Claims have been made that bone repair has taken place very rapidly after the operation, and Calot and Ducroquet both present radiographs which are intended to prove this. The reproductions from these, however, are very far from satisfying, and one must be decidedly doubtful when it is realized that all of the pathological material which it has been possible to study shows little, if any, attempt at the formation of new bone. As tuberculosis of the spine is not essentially dissimilar from tuberculosis of the other bones and joints, and as the pathological condition found in the specimens which have been examined is entirely similar to the condition found after like treatment in other joints, it is probable and reasonable to suppose that the process of bone repair has not been radically changed by mere forcibly straightening the spine.

The immediate results of the work are most striking; but if this is to be the chief purpose, and unless the after-treatment is carried on most patiently and intelligently for years afterward, certain it is that the ultimate results will be as disappointing as the first results have been gratifying, and that relapse will be the rule. Already relapses have been reported by Péan, Phocas, Tansch, Lorenz, and Vincent, and many others must follow, if a few months of after-treatment, as Calot would have us believe, is all that is necessary to accomplish a cure. It must be remembered that simple straightening of the spine does not materially alter the course of a tubercular disease. It may be slightly modified in some regards, but the disease is still the same.

Much good, however, will certainly follow the introduction of this method, and it will undoubtedly have its place as a part of the treatment of Pott's disease; and as the result of it in the future, humpbacks will, in all probability, be less common.

From my own experience, it seems to me that the chief place for the operation is in the very early stages of the disease, before extensive destruction of the bone has taken place. In these cases, instead of fitting apparatus to hold the bones in the deformed position, the spine should be over-extended and the jacket or the appa-

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ratus applied in this position. By doing this the weight is removed from the bodies of the vertebræ as much as possible, and the irritation due to the diseased bones rubbing together is very largely relieved. It is reasonable to suppose that, as a result of this, the course of the disease will be somewhat shortened, and that the destruction of the bone and consequent production of deformity will be lessened.

In the cases in which there is paralysis the operation is, without question, the best treatment; and in a certain number of other cases in which there is marked deformity, with the narrow chest and poor general condition, and where the deformity is increasing, the operation should be undertaken. In this latter class the general condition is improved by the more erect position, with the freer chest movement, so that the vital resistance is increased. In these cases the support should be worn until the patient has attained the full growth, and then when removed the relapse or the development of the deformity will be comparatively slight, as the ribs will then be firm enough to help in maintaining the erect position.

CONCLUSIONS. It has been clearly shown that similar operations have been performed at different periods in previous centuries.

The operation, as simplified by the writer, has been performed in a large number of cases, upon which the paper is based.

An apparatus is described by which it is possible to accomplish the correction without the necessity of a large number of assistants, and which makes it possible to apply the plaster-of-Paris jacket with marked hyper-extension of the spine.

No unpleasant results have been experienced, and in the five cases in which paralysis was present the recovery was almost immediate.

In the acute beginning cases the operation seems to promise a moderate diminution of the existing deformity, and, with the method of after-treatment as advised, it is probable that the course of the disease will be shortened, and that the usual increase of the deformity will be avoided.

In cases in which there is marked deformity the operation is justifiable at times, in order to secure better respiratory and digestive action, as well as to improve the position of the spine. In these cases considerable relapse is to be expected, owing to the extensive destruction of the bones and the imperfect osseous repair which takes place in tubercular disease.

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THE FORCIBLE REDUCTION OF DEFORMITY IN POTT'S DISEASE.

By FRANK E. PECKHAM, M.D.,
PROVIDENCE, R. I.

THE forcible reduction of deformity in Pott's disease as performed and described by Chipault and Calot has been of the greatest interest to medical men the world over. It has caused much discussion abroad, and is now engaging the active attention of American surgeons. It has been demonstrated that the immediate reduction of the deformity is a safe procedure, the discussion hinging on the ultimate result, whether the spinal column will be held in its corrected position by bony anchylosis, or whether, with the removal of support, the deformity will recur. There is much to be said upon both sides, but all arguments are valueless, and the only solution will be to await the facts. Then there will be a solid foundation upon which to stand, and we shall know how much can be done and what cases are most favorable for this treatment. Although it is too early yet for these ultimate results, the preliminary work as reported by various observers has taught us a great deal, and, if this method is to become a recognized procedure, will enable us at once to treat all suitable cases with the utmost confidence. As to the cases suitable for this operation, it can easily be demonstrated without ether by means of extension and direct pressure, gently applied, whether or not there is any yielding. If there is, it may be inferred that the deformity is susceptible to treatment. Where there is firm bony anchylosis I should consider forcible correction contraindicated. In the cases where paraplegia is present I believe it is an operation that can be urged with the greatest confidence, because the mortality rate ought to be practically nothing, and the results are excellent, while a laminectomy is a very serious operation.

My work in this line began in October, 1897.

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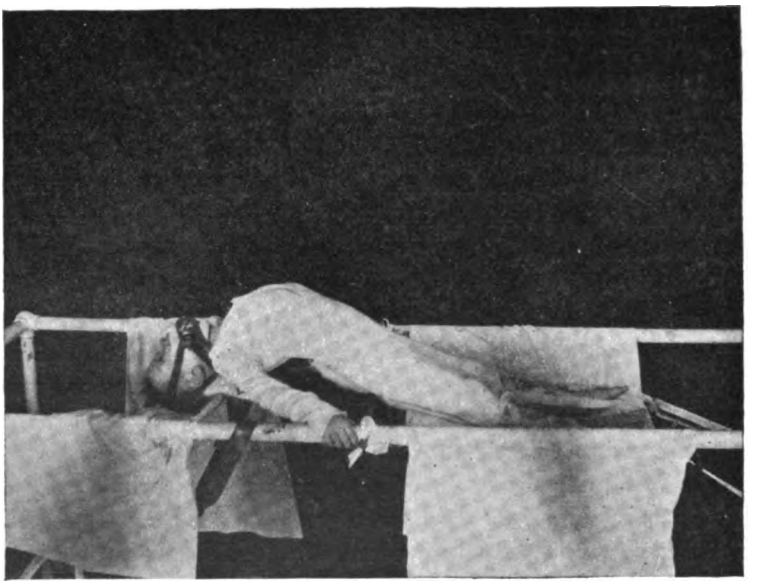
CASE I. The patient, a boy, ten years of age, entered the Rhode Island Hospital March, 1897, with Pott's disease of two or three years' duration. There was a moderate amount of deformity in the upper dorsal region, with complete motor paralysis of the lower extremities, which had been present for seven or eight months before entrance. Patient was placed on a Bradford frame and extension applied to head and legs. As time went on the boy became more emaciated, sensation disappeared from the legs, and in May, 1897,

FIG. 1.



Patient in position on a Goldthwait frame.

laminectomy was considered with Drs. Mitchell and Munro in consultation. At that time it was thought best not to operate. His condition remained unchanged up to October 18, 1897, when the first stretching operation was done. The patient, after being etherized, was placed across two padded blocks, one being at the level of the top of the sternum and the other at the level of the anterior-superior spines of the ilium, the body in this way being raised about six inches above the level of the table. One assistant then grasped the thighs firmly, while others pulled on the head and arms.

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While thus being stretched lengthwise the operator forcibly pushed the spine down into place. When it gave way the crackling and snapping were distinctly heard, and could be felt by all whose hands were in contact with the body. Plaster was applied from the hips up to the level of the axillæ; then the patient was suspended by attaching the head-piece to the cross-bar of a Sayre apparatus and the head and neck were included in plaster. There was only a slight amount of shock following this operation, which rapidly disappeared.

On November 24, 1897, sensation had returned to both legs, even to the tips of the toes, and the cremaster reflex was active. From the first operation the ankle clonus acted in a very peculiar manner. At one time it would be improved or even absent in one foot, but not in the other, and this improvement would alternate from one foot to the other. This erratic symptom continued, but slowly improved, until January 5, 1898, when, although clonus was present, it could be stopped instantly by a voluntary muscular effort of the patient. On January 21st the spine was again stretched and plaster reapplied, as before, this being the third time.

On March 9th, a little less than five months from the first operation, the clonus had completely disappeared. April 23d plaster was reapplied without ether, with the patient lying upon a frame, according to the method described by Dr. Goldthwait. This time the head was not included in plaster, and the boy was allowed to sit up for the first time. In this case the paralysis was considered to be due to a thickening or to adhesions about the cord, and the treatment has been entirely successful.

Case II. A. B., a girl of seven years, entered Rhode Island Hospital, May 4, 1897, with a marked kyphosis in mid-dorsal region; duration of disease two and one-half years. On entrance there was an abscess on each side of the spine, extending from above the level of the deformity to the bottom of the sacrum. The child was in a septic condition, with a weak, rapid pulse, extremely emaciated, and looking like death. The abscesses were opened on the day of entrance, a quart of pus being evacuated from the right side and a pint from the left. Improvement was immediate, and continued until the child was in excellent condition, a small sinus remaining in the right lumbar region.

October 27th, five and one-half months after the abscess opera-

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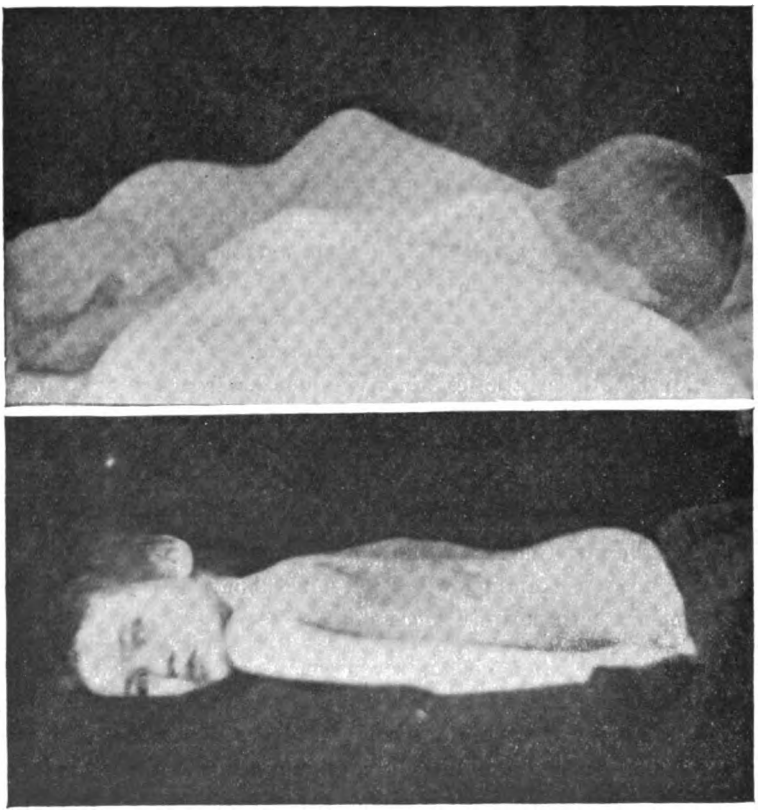
tion, forcible reduction was done, using Calot's method. The spine yielded with very loud crackling, and went down easily, but could not be completely straightened, a very slight deformity remaining. There was severe shock for the following two or three days, and the patient seemed at the point of death. The plaster head-piece was

FIG. 2.



Case II., before and after treatment.

removed and the jacket loosened for comfort. The patient rallied on the third day, and there was a rapid return to a good physical condition. The mistake here was in attempting to reduce so great a deformity at one sitting, consequently at the second reduction, November 19th, only a small amount of correction was attempted. At

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this and subsequent operations there was practically no shock. Reductions were made under ether December 29, 1897, and February 4 and March 18, 1898. The last two times, although there was comparatively a very small amount of deformity remaining, it was impossible completely to obliterate it by this method.

FIG. 3.

Case II., standing erect in plaster-of-Paris jacket.

On April 22d the patient was placed upon a frame, as described by Dr. Goldthwait, extension made without ether, and plaster applied, but the slight deformity shown in the photograph still remains, and probably this represents the permanent result.

CASE III. M. A., a boy, aged five years, entered Rhode Island Hospital October 30, 1897, with a lumbar and lower dorsal caries and a moderate deformity. The duration of disease was only a few months. December 2d forcible reduction under ether, and in this case plaster applied only up to the level of the axillæ, but with considerable lordosis in an attempt to hold the deformity over-corrected.

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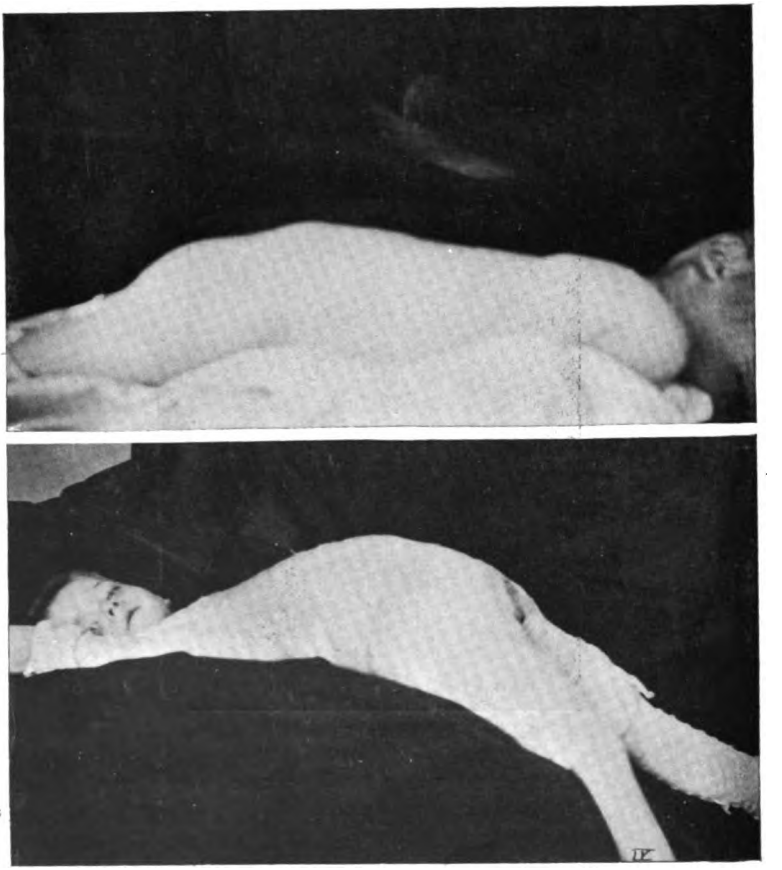
Plaster thus applied was inefficient, because any flexion of the thighs tilted the pelvis, resulting in a backward projection of the spine and increasing the deformity. Consequently, at the second opera-

FIG. 4.



Case III., before and after treatment.

tion, January 21, 1898, the patient was held in extreme lordosis, and plaster applied from the knees up to the level of the axillæ, and then a bed arranged so that he rested comfortably in that position. This position was maintained until February 7th, a little over three weeks, when a back-brace was applied, and on February 25th the

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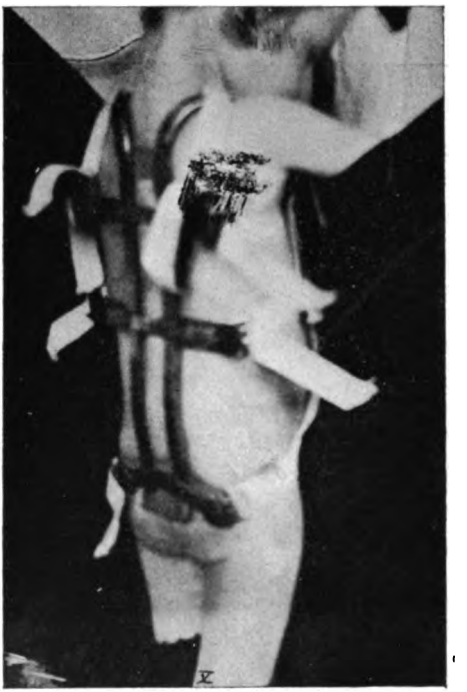
patient was sent home. I have seen this case within ten days, and the spine is still held in the position shown in the photograph. Although two corrections were made, it was only after the last one

FIG. 5.



Case III., final result.

that the spine was held successfully, requiring about three weeks of plaster to accomplish it, thus showing that in these early cases it is much easier to get desired results.

CASE IV. F. K., a girl, aged four years, entered Rhode Island Hospital May 7, 1897. There had been a Pott's disease, with deformity in the upper dorsal region, for about three years, and a left hip disease had existed for several weeks. Operations by Calot's method December 29, 1897, February 4 and March 4, 1898. Fig. 6 shows the result up to March 4th. On April 28th plaster was applied on a (Goldthwait) frame without ether.

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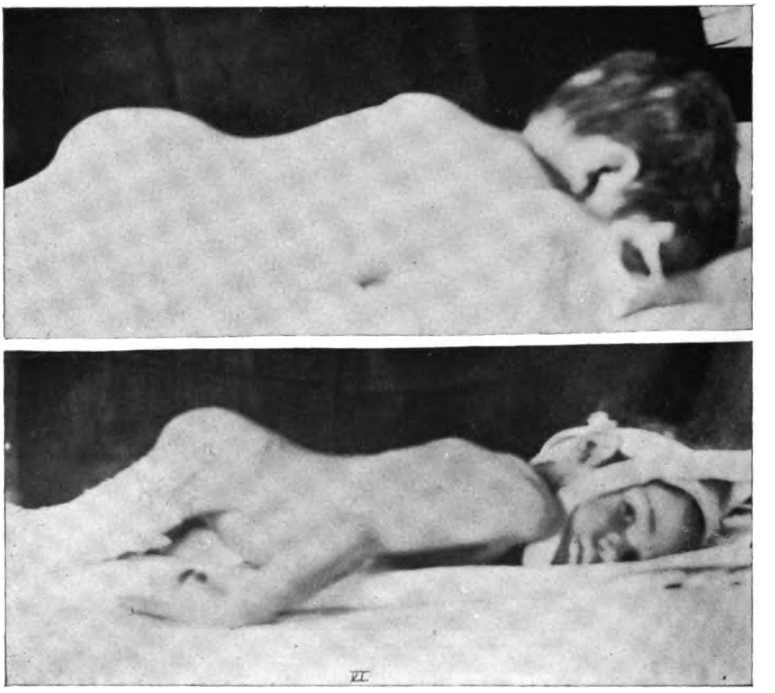
CASE V. E. B., a boy, aged seven years, entered Rhode Island Hospital April 27, 1897, with a Pott's disease and resulting deformity in upper dorsal region of three and a third years' duration. Marked ankle clonus was present. There was no motor or sensory paralysis, but the boy was unable to walk on account of paresis and

FIG. 6.



Case IV., before and after treatment.

the jerky movements. Operation with ether (Calot's method) on January 4 and 22, 1898, with the result on the deformity as shown in Fig. 7. On May 10th the patient was placed upon a frame and plaster applied without ether, while double extension was made upon head and legs. The ankle clonus is behaving just as it did in Case I., becoming slowly diminished, and can now be controlled with a voluntary muscular effort on the part of the patient.

CASE VI. W. D., a girl, aged three years, entered Rhode Island Hospital with Pott's disease and a deformity in the upper dorsal

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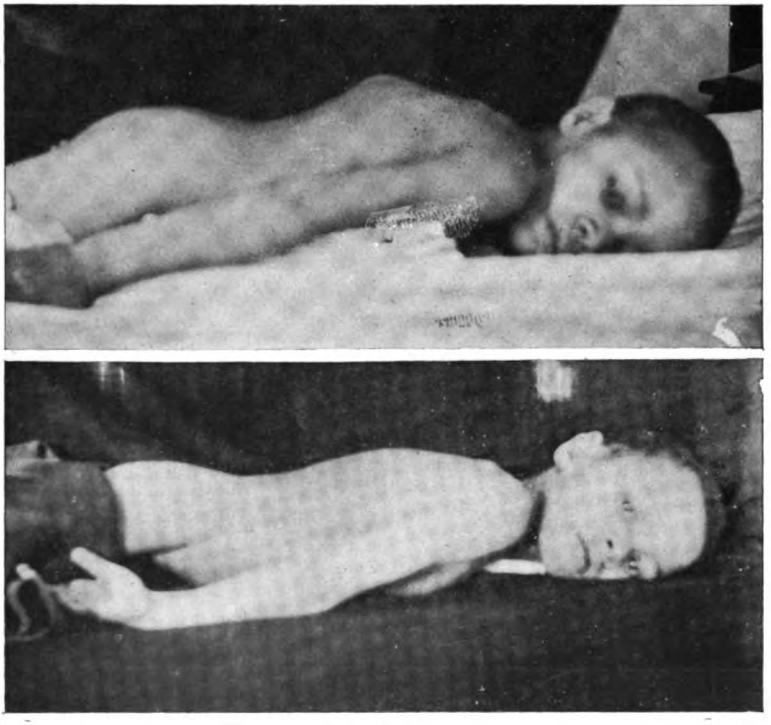
region, as shown in Fig. 8. This condition had existed for about two and one-half years, in April, 1898. The improvement shown is from one application of plaster upon the frame, without ether.

After these operations by Calot's method there is always an increase in the pulse-rate. In the first cases there was some pain

FIG. 7.



Case V., before and after treatment.

complained of, but at no time was an opiate necessary. After the first two or three times, becoming more acquainted with the details, and consequently doing it much more rapidly, there was scarcely any shock, and a patient operated upon in the afternoon would almost invariably be ready for breakfast or dinner the next day, as if nothing had happened. In Calot's method the patient is held over the blocks until the plaster reaches the level of the deformity, then sus-

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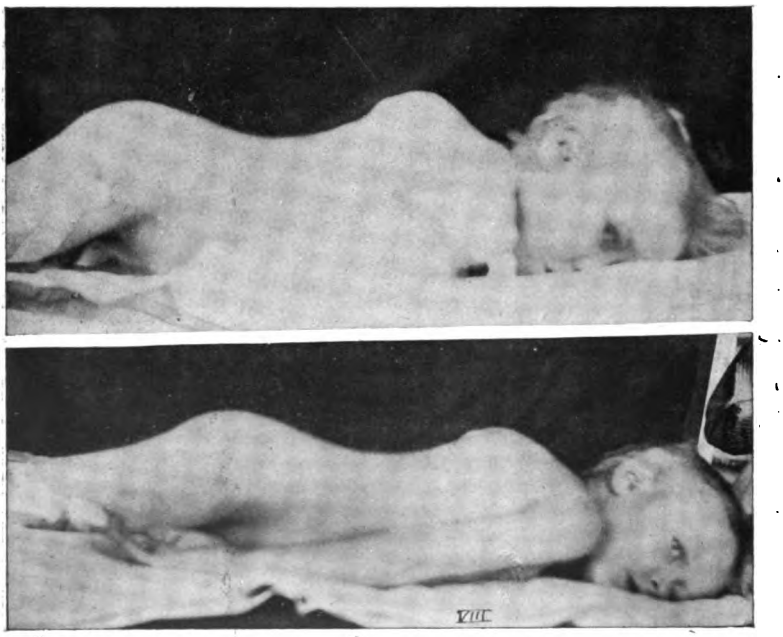
pended by the head while the application is completed, the weight of the body suspended being considered sufficient to keep the deformity reduced. I have found that this is not so, and have always had an assistant to make extension upon the legs during the suspension; but even then the deformity cannot be held completely reduced, and it will be seen from the photographs exhibited that in no case have I been able completely to obliterate it. By Goldthwait's

FIG. 8.



Case VI., slight improvement after one treatment on the frame, without ether.

method this difficulty is rendered less troublesome by making extension while the patient is placed back downward over the longitudinal bars, these bars having their convexity upward. Thus the spine can be over-corrected and the plaster applied while this position is maintained. Whichever method is employed, it is surprising how little the patient is discommoded, about the only thing being the unpleasant effects of the anæsthetic, and, latterly, in attempting to see how little ether could be used; even this has been reduced to almost nothing.

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As stated before, the immediate and forcible reduction of deformity is possible without injury to the patient, and it remains to be seen what the ultimate results will be, and how much time must elapse before these reports begin to come in. As far as has been demonstrated up to the present time, it is of greatest use in the early cases with beginning deformity. Here, by means of the frame and convex parallel bars (as devised by Dr. Goldthwait), the deformity can be corrected easily and without ether. In cases of paraplegia it is the operation *par excellence*. In old cases, and especially those with large angular deformities, the advisability of operation depends entirely upon the fact, yet to be proved, whether or not bony anchylosis will be the final condition.

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FORCIBLE STRAIGHTENING OF SPINAL CURVATURE.

By JOHN RIDLON, M.D.,
CHICAGO.

The immediate straighteniug of spinal curvatures by the use of considerable force is, as you know, no new procedure. Two thousand years ago the method was so old that the name of the author had been forgotten. The only new thing in the revival of this method of treatment is that the patient is profoundly anæsthetized during the operation.

I made my first attempt at forcible straightening of the spine with the patient fully anæsthetized on June 23, 1897. Since that time I have made the attempt in every case coming under my observation in which it seemed to me admissible, and in which, after fully explaining the operation and its results to the parents, permission to operate could be obtained.

I think I have learned some things from my personal experience, but there are still several points upon which I feel some doubt, and it is these I would like to have discussion upon. In spondylitis:

1. Is there any risk to the patient except dissemination of tubercle and death from general tuberculosis and of tubercular meningitis?

2. What additional percentage of risk is there from dissemination of tubercle?

3. Does the presence of a demonstrable abscess or of a sinus add to the risk?

4. How much of a relapse, or return, of the deformity must we expect during treatment by recumbency and fixation-dressings?

5. What are the best fixation-dressings during recumbency, and afterward?

6. Can we reasonably expect the gap between the carious bone surfaces produced by the operation to fill in and solidify with bony

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material, so that relapse of deformity after the healing of the tuberculous process will not take place?

7. Will the period of treatment be prolonged or shortened by the operation, and about how long will that period be?

8. Is the use of an anæsthetic an advantage or a disadvantage?

In scoliosis:

1. Is there any risk in forcible straightening?

2. What degree of gain may reasonably be expected?

3. Can the gain from forcible straightening be maintained?

In rhachitic curvatures:

What may we reasonably expect from forced straightening?

On October 5, 1897, I read a paper on this subject before the Mississippi Valley Medical Association at Louisville, reporting the cases operated upon by me up to that time. The paper was not published, but was emended and amplified, and again read on December 23, 1897, before the Chicago Medical Society. It was published in abstract in the February number of the *Chicago Medical Recorder*, and in full in the *Journal of the American Medical Association* of March 26, 1898.

Altogether I have attempted the operation upon sixteen cases of spondylitis, seven cases of scoliosis, and one case of rhachitic curvature. One patient reported in my October and December papers as scoliosis, and included here among the seven cases of scoliosis, I am inclined to regard as spondylitis, because the patient's mother died of tuberculosis, and because the deformity, though lateral and posterior, was very great for so short a duration as two years; because the sensations communicated to the hands of the operator during the straightening were identical with those felt in straightening cases of spondylitis and quite different from those felt in straightening cases of undoubted scoliosis, and because of the utter helplessness of the patient when the jacket was removed on account of an attack of typhoid fever eight months after the straightening.

I will not enter into details of the cases already published, but those since December 23, 1897, are as follows:

CASE I. Female, six years old; spondylitis, duration two years; family history negative; a traumatism preceded onset; previous treatment of various kinds. The deformity present is shown by

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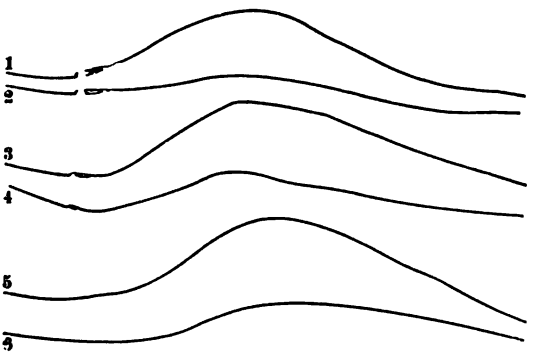
the first tracing; there was a sinus from an old abscess in the left loin. On December 28, 1897, the spine was straightened to the point shown in the second tracing, and a plaster-jacket applied during horizontal traction.

CASE II. Male, ten years old; spondylitis, duration seven years; family history negative; traumatism preceded onset; has been treated for some considerable time with an antero-posterior spine-brace The deformity present is shown by tracing 3, and there was present a large undescended psoas abscess. On January 6, 1898, the spine was straightened, as shown in tracing 4, and a plaster-jacket was applied during horizontal traction.

CASE III. Male, six years old; spondylitis, duration more than nine months; family history negative; a traumatism preceded onset; has been treated with an ill-fitting antero-posterior brace. The deformity present is shown by tracing 5; there were no complications. On January 8, 1898, the spine was straightened, as shown by tracing 6, and a plaster-jacket, including the head, was put on during suspension by the feet.



CASE IV. Female, ten years old; spondylitis, duration four years; family history negative; traumatism preceded onset; was treated for six months with a plaster-jacket; then paraplegia developed and was treated by recumbency and more or less weight-and-pulley traction for a year, until the paraplegia had disappeared; then by an antero-posterior spine-brace and chin support to the

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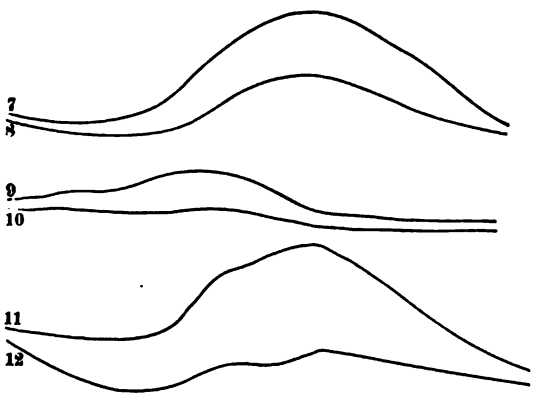
present time. The deformity present is shown by tracing 7. There are complete motor paraplegia and partial sensory paraplegia, and the legs are cold and blue. On January 18, 1898, the spine was straightened, as shown by tracing 8, and a plaster-jacket, including the head, was applied during suspension by the feet. The patient was able to move the limbs immediately upon recovering from the anæsthetic, and after twenty-four hours the limbs were warm and of good color, and sensation had returned. There was a partial relapse of the paraplegic symptoms, and a second operation was made on February 24, 1898, which was followed by a complete disappearance of the paraplegia.

CASE V. Male, thirteen years old; spondylitis, duration eight years; family history negative; cause unknown; has been treated in various ways. The deformity is shown by tracing 9, and there are undescended psoas abscesses on both sides. On April 13, 1898, the spine was straightened, as shown in tracing 10, and a plaster-jacket was put on during horizontal traction.



CASE VI. Female, five years old; spondylitis, duration about two years; family history negative; cause unknown; previously treated by an ill-fitting steel brace. The deformity present is shown by tracing 11. There has been a cough for the past two months, and there is possibly pulmonary tuberculosis. On April 14, 1898, the spine was straightened, as shown by tracing 12, and a plaster-jacket, including the head, was applied during suspension by the feet.

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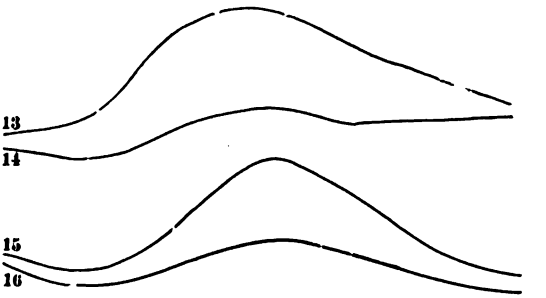
CASE VII. Male, nine years old; spondylitis, duration five years; family history negative; cause unknown; previous treatment by a brace applied by an instrument-maker, followed by a brace applied by an orthopedic surgeon. The deformity present is shown by tracing 13, and there is an undescended left psoas abscess. On April 20, 1898, the spine was straightened, as shown by tracing 14, and a plaster-jacket was put on during horizontal traction.

CASE VIII. Male, five years old; spondylitis, duration one year; family history negative; traumatism preceded the onset of deformity; previous treatment by an ill-fitting steel brace. The deformity present is shown by tracing 15. On May 5, 1898, the spine was straightened, as shown by tracing 16, and a plaster-jacket was put on during horizontal traction.



As to the cases of scoliosis, the histories present nothing of special interest. The youngest patient was nine years old, with a deformity that had been recognized for a year and a half, and the oldest was eighteen years old, with a deformity of five years' duration. All of the cases were straightened at least one-quarter, and none of this last series more than one-half; all were put up in plaster-jackets while suspended by the feet.

The patient in whom rhachitic curvature was present, was a male seventeen years old, and the deformity dated from infancy. There had been no increase of the deformity for fourteen years. The operation was performed on January 13, 1898, and nothing was gained in the way of correcting the deformity.

Taking into consideration all my cases of spondylitis, four had demonstrable abscesses, one had an old sinus, and one had para-

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plegia. No harm appears to have arisen from the abscess complication or from the presence of the old sinus. The paraplegia appears to have been very positively benefited. Two patients stopped breathing on being turned from the prone to the supine posture during chloroform narcosis, but both began to breathe again after a short interval; in one instance the plaster-jacket was cut open and allowed to gape an inch, and in the other it was not. Only one case has shown any elevation of temperature after the operation, and in this instance we have no evidence that elevation of temperature was not present before the operation (see Case VI.). In two instances (see former report) it was not possible to straighten with what seemed to the operator a safe amount of force. Pressure-sores under the plaster dressing have been frequent. Their locations have been over the kyphosis, over the scapular spines, over the posterior iliac spines, over the sternum, and in various places about the head. In all cases the deformity has relapsed to some extent. Relapsed deformity can usually be greatly reduced by horizontal traction and hyperextension of the spine, without the use of an anæsthetic, by bending the patient backward over a foot-rest during the setting of the plaster-jacket. Only two cases have been allowed to get up and walk around: one in a plaster-jacket and one in an antero-posterior spine-brace. In no case as yet do I think I have obtained reliable bony solidification at the point of disease.

As to the cases of scoliosis, forcible straightening appears to be useful in limbering up a rigid curve, but some relapse of deformity must be expected, and a reliable retentive support must be worn for a very long time.

As to rhachitic curvatures, I believe these may be forcibly straightened in young children, despite of my failure in the seventeen-year old patient.

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DISCUSSION.

DR. HENRY LING TAYLOR said that his impression had been strengthened by listening to these papers, that, after all, the real problem was to hold the spine. While we were indebted to the French method of Calot for increased interest in the treatment, and while it would doubtless result in a distinct advance, he believed that the advance would be mainly on the lines of securing better spinal support. The extravagant claims put forward by those who revived this method had so far not been fulfilled; on the other hand, the extravagant fears of those who were timid regarding any operative interference in this direction had been proved to be for the most part groundless. Auto-correction repeated at intervals on the horizontal frame, as demonstrated by Dr. Goldthwait, seemed to the speaker to be the most promising of the newer methods.

DR. SHAFFER said that the method, if used at all, would seem to be of especial value in disease below the seventh cervical and above the twelfth dorsal vertebræ. In disease of the dorso-lumbar and cervical regions good results could be almost always secured with proper mechanical treatment. In the mid-dorsal region, where there is fixation of the spine produced by the ribs and a normal kyphosis, and where the normal rigidity of the vertebral column does not allow of putting the spine in a position which modifies traumatism, the question of forcible reduction has a peculiar interest. It is a great relief to know that bad results had not followed this method of treatment. Granting that the pathological curvature may be reduced, which I doubt, what can we say of the permanency of the result? In the only case with which I have been familiar with this forcible treatment, it was endeavored to ascertain chiefly how much of the pathological deformity could be reduced, and how much of the benefit in position was due to change of the compensatory curves of the spine. A good deal of the apparent reduction of the deformity gained in this condition, as in suspension, is due largely to modification of the compensatory curves, and not to a decided change in the boss itself. If we could fill the gap, and I do not think we make any, as the dentist fills a carious tooth, much more might be ex-

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pected from the method. The whole argument hinges upon what nature will do in the way of filling in this gap, provided we can really reduce the true curvature. The question will not be answered for four or five years, or until after a large mass of clinical material has been accumulated. Personally I have advised against the operation in several cases, and I had no faith in our ability to maintain the gain, which is apparent rather than real. I regard it as an operation which appeals to our imagination rather than to our good sense, and we cannot expect good results in the present state of our pathological knowledge of tubercular disease of the spine.

Dr. R. H. Sayre said that from the fact that forcible reduction seems to be about as old as the history of medicine, and has had various periods of revival and abandonment, the great problem seemed to be the holding of the spine after the deformity had been reduced. It was also of the greatest importance that orthopedic surgeons should learn to prevent such deformities—in other words, to make an early and correct diagnosis, and institute effective treatment. Some of the English surgeons seemed to think that the spinal column did not fill up after there had been erosion of the bodies of the vertebræ. They stated, therefore, that a crooked spine was better than a straight spine, the idea being that the former is solid while the latter has a gap which greatly weakens the column. Such a view is entirely at variance with the teachings in this country. In straightening crooked tubercular knees and hips it is well known that the deformity was apt to recur if protection were not applied for very long periods, and that some cases of inflamed tubercular joint seemed never to recover sufficiently to allow of the removal of the artificial support. He thought it probable that the same would prove true regarding many spines which had been forcibly straightened. In addition to the danger of disseminating tuberculosis after forcible correction, he thought there was a danger in certain cases from rupture of abscesses and flooding the lung with pus, and also, exceptionally, of rupture of the aorta as it winds around these twisted spines. He did not recall any reported case of rupture of an aneurism, but one or two cases had been placed on record in which there had been a rupture of an abscess during anæsthesia. One of these occurred years ago, shortly after the introduction of

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the plaster-of-Paris treatment by his father. A certain German surgeon had endeavored to straighten the spine by applying greater force under an anæsthetic than he would use without it before the application of the jacket. He happened to try the plan on a case with abscess, and the consequent rupture of the abscess caused the death of the patient. In 1885 a large series of cases had been reported by Nabel, in which decided straightening of the spine had been secured by longitudinal traction without an anæsthetic. Probably some cases could be just as well straightened without as with an anæsthetic, but there would always be some in which an anæsthetic would be demanded. He doubted very seriously whether it was wise to exert very great force in the effort to reduce the deformity; the method was old, and had passed out of use.

Dr. Ridlon had spoken of an interesting point—*i. e.*, the girdle band due to irritability and muscular spasm. The speaker said that he had recently spoken of this fact, and had stated that his father had pointed it out almost twenty-five years ago. It was analogous to the muscular spasm met with in other joint affections.

Dr. C. C. Foster, of Cambridge, thought there was no occasion to worry about the spine throwing out callus and becoming solidified, but it should be remembered that this process cannot begin until the active tubercular process has been completed. It seemed to him that a straight bone would unite just us well as, if not better than, a crooked one. He had done much for his cases while they were in bed by making the weight of the body do the work. For this purpose he had used a transverse ridge in the bed at the point of kyphosis, while traction was made. It was surprising what an amount of straightening could be obtained in this way by simply utilizing the body-weight. There is nothing better than patience and rest in bed for the relief of muscular spasm.

Dr. A. J. Gillette said that he appreciated some of the objections made to the ordinary chin-piece and jury-mast, but he could not see what there was in Blanchard's brace which would prevent the patient from getting away from it.

The spasm referred to by Dr. Ridlon was not that form mentioned by Dr. Sayre; as Dr. Ridlon had said, there was an inter-

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mittent muscular spasm which appreciably increased the deformity and was not associated with pain. When he had seen this patient the spasm had been limited to the concave side. Dr. Gillette said that he had treated the patient by extension on the table. He had been afraid to use a plaster-of-Paris jacket because of the danger of producing excoriation from the muscular spasm. He had had one other case of severe spasm, which had greatly improved under general tonics, but he had just learned that the spasm had returned in a marked degree.

Dr. Judson said that this treatment by forcible correction was, of course, in a very early experimental stage. He had seen no reason to be dissatisfied with the treatment which produces long-continued support during the time of growth, and properly made by a progressively adjustable steel brace. As had been already said, one benefit was likely to be seen from this revival of the treatment—*i. e.*, special pains would be taken to apply mechanical support properly and continuously.

What had been said about muscular spasm reminded him of a condition met with by neurologists, in which the different parts of the body or extremities were affected by rhythmical contractions. It was undoubtedly a nervous affection, but in Dr. Ridlon's case was probably connected with the disease in the spine.

Dr. Weigel said, regarding the improvement in general health referred to by Dr. Goldthwait, that he would like to ask whether the improvement was greater than in those cases which are treated by efficient support. All had seen remarkable improvement follow the application of proper mechanical support to the spine by the older methods. What had been said about the plaster jacket showed the difficulties that are inevitably associated with the fixed plaster jacket. A number of years ago he had abandoned the fixed jacket as a means of support, and had obtained better fixation and better results by using a removable plaster-of-Paris jacket such as is employed in scoliosis. A possible objection might be that some of the improvement obtained during recumbency would be lost.

With reference to the case of Dr. Ridlon in which there was doubt as to its being Pott's disease or scoliosis, he thought the

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question could be settled beyond a doubt by having a radiograph made of the case.

Dr. Weigel exhibited a skiagraph to show how, with an exposure of twenty minutes or less, in a girl of nineteen, an excellent radiograph of the spinal column could be obtained, and one exhibiting much detail.

Dr. A. M. Phelps said that he had forcibly straightened a number of cases of Pott's disease. He believed that every one of them would relapse except those operated upon very early, before a large kyphos had formed. Where there is a small kyphos there is only a slight gap between the bodies of the vertebræ, which would probably fill in with bone and result in a cure. Where the gap was large it would not be filled in, for the reason that fibrous tissue grows over the ends of the bones, and subsequently connective tissue and fibrous tissue fill in between the ends of the bones, and bony union does not take place. The demonstration made last evening seemed to prove this. It was for this reason that he was now wiring all of the spinous processes firmly together. The operation is a very simple one. A hole is drilled through the upper one above the kyphos, and then the wire is woven in and out until the entire kyphos is firmly fastened together. This he believed to be the only method of obtaining a cure. In doing this he had followed a suggestion made by a French surgeon.

About 10 per cent of these cases, without operation, would die from dissemination of the tuberculosis, and if the same percentage die with operation, it is evident that surgical interference has not increased the risk in this respect. The amount of risk from metastasis had not been at all accurately determined. In all cases of extensive deformity he felt positive that forcible straightening should not be done unless it were supplemented by wiring of the spinous processes. He looked upon the plaster-of-Paris corset as the best support, but it should be put on and left on, so that the patient or relatives would be unable to take it off. It would take a number of years before the ultimate results could be known. Personally, he had decided to operate upon fifty cases, and then stop.

Dr. Sayre said that the spasm to which he had referred was not a spinal spasm, but like a "puckering string" about the belly. He

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had not observed it, however, in the rhythmical form referred to by Dr. Ridlon.

DR. KETCH asked Dr. Phelps if he had said that 10 per cent. of cases operated upon die of general tuberculosis.

DR. PHELPS replied that Dr. Ridlon had made the statement that 20 per cent. die from this cause.

DR. KETCH said that in his opinion this was a very high percentage; he knew of no statistics which show that 10 per cent. die of tuberculosis of the lung or of the meninges when not operated upon.

DR. RIDLON said that he felt that the upper lumbar region was just as favorable for this work as the lower dorsal region, of which Dr. Shaffer had spoken. He had not always been able to straighten out the lumbar spine by brace treatment, and hence he felt that there was a useful field for forcible straightening even in such cases. The danger of rupture of an abscess into the lung must depend upon the amount of force used and the judgment of the individual operator. He had not found that tubercular abscesses were easily ruptured, and he would not expect to be able to tear open a healthy lung with his hands if the lung were outside of the body. He had certainly never used enough force to tear a healthy aorta, even though it curved around the deformity, and he did not believe he could.

DR. GOLDTHWAIT explained that the two loose steel pieces connected with his frame are incorporated in the jacket, and are removed after the jacket has hardened. Pressure-sores are very apt to follow the treatment, no matter how carefully the padding is made, unless a window is cut out over the boss. The improvement in the case to which he had referred was apparently due to the fact that the straightening of the thorax had allowed of better breathing.

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EPIDEMIC INFANTILE PARALYSIS.

By E. G. BRACKETT, M.D.,
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In view of the present theory classifying infantile paralysis among the infectious diseases due to some specific germ, the epidemics which can be studied become of particular interest, and especially so since as yet there have not been a great many reported. In these the general characteristics of the affection closely enough resemble the ordinary type to allow a comparison to be drawn between the two classes of cases. Although in the ordinary case there is apparently no relation to contagion, to location, or to environment, or other condition except that of the season of the year, yet it can be classed etiologically among those diseases which are due to the action of some organism in a definite anatomical region.

The epidemic cases, however, although bearing a close resemblance to the isolated and endemic ones, show certain points of difference from these, and with well-marked regularity, these differences being mainly such as might be expected from a more virulent type of an affection or a more active germ. Any relation, therefore, which may be traced between these cases and an epidemic, or to any form of contagion, becomes of interest from its bearing on the connection that this may have with its infectious nature.

The series of cases which are here presented occurred during an epidemic in North Adams during the summer of 1894, and they possess an additional point of interest from the ordinarily reported epidemics in that the opportunity has been presented to study them at a remote period from the time of the attack. The probable existence of an epidemic in this region was brought to notice through the statement of a parent of one of the victims, and the attempt was then made to investigate the series, although it was recognized at

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the time that the early history of many of the cases must necessarily be imperfect when obtained from history alone at this date. The place is not large, and the number of cases was not great, but showed enough of the epidemic character, and also points enough with relation to their disposition and occurrence, to warrant their study and their being placed on record.

In all, ten cases have been seen and examined, and in all but one a satisfactory history has been obtained from such data as could be had from the parents and the attending physician. These occurred, with one exception, between the middle of August and September 18th, the first case appearing July 25th. These include the cases only which occurred in this town; but there were undoubtedly others scattered about in the vicinity, which were described while investigating these, but were not seen, as it seemed better to confine the work to this region. In clinical character the cases are distinctive of the well-recognized type of acute poliomyelitis, a number, however, being of an unusually severe type. The details of the individual cases will not be considered,[1] as they do not present any special interest, but certain characteristics of the cases in general, and the presence of special symptoms which were met with, possess interest from their relation to the epidemic.

The cases may be considered with relation to the following symptoms, which will present the characteristics of the series as a whole.

Method of Invasion and Initial Fever. The invasion, on the whole, was rather sudden, marked by such varying symptoms as would lead one to expect some form of pronounced infection, but in a few was of a mild type, not attracting particular attention until the appearance of some other and more definite symptom. In the majority of cases the attack was ushered in by fever, headache, vomiting, and occasionally delirium or stupor, and preceded by a distinct interval of the special symptoms. The duration of these symptoms until the paralysis was noticed varied from one day to twenty-one days. This condition was accompanied by initial fever, which was marked and severe in three cases. In two cases during this period there was stupor, and in one delirium.

Bladder and Rectum. An unusually large proportion showed

[1] See table.

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loss of control of the sphincters, which was not altogether transitory. Of the ten cases, eight presented loss of control of one or both. Of the eight, the bladder was affected in all, and in three of these the rectum as well. Two still have incontinence. In one other, this lasted fifteen months. Of the three in whom the rectum was affected, one did not regain control for fifteen months and another for two years.

Hyperæsthesia is a well-recognized symptom, frequently seen in the usual type, and in this series was found in five. This was not an ordinary sensitive condition, but very marked, such that in some the weight and friction of the bedclothes could not be borne. In one there was loss of sensation, a condition very rare, but one that had been observed in previously-reported epidemics.

Special Symptoms. Three cases presented special symptoms—loss of speech in two, which lasted from three to four months in one instance and one year in the other, and blindness in one, which lasted two weeks.

The distribution of the paralysis was not different from the ordinary type, except that it was more extensive and the trunk muscles were apparently affected to a much greater degree. This occurred in a majority of the cases, and in two or three this has persisted to the present time, showing evidence of the loss of complete control of muscle power.

The topography of the region is one of interest, as it is rather peculiar, and may have a bearing on influential causes of the distribution, if not on the etiology. The town is situated between high lands, and through it run two rivers, a north and a south branch, which join at one end of the town, with much of the intervening land low and swampy. The river is foul, and is used for carrying away the waste of several large factories.

The cases were, in general, scattered along near one or the other of these two rivers, with one exception, this case being situated in the middle of the town and half-way between the two rivers.

Although this contiguity may not necessarily be regarded as the cause of the disease, it may very well be influential in presenting conditions which are favorable to its development.

Although these cases show a very close resemblance to the ordinary sporadic form of this disease, they seem to differ in some respects from

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the ordinarily-met-with and mild type of case. In general, they resemble the usual type of the acute poliomyelitis enough to class them without question as examples of this disease, and the subsequent history, as well as the condition at present, completes the picture. The chief differences were, however, in such characteristics as would result from a more virulent type, and one in which the pathological process was less closely confined to the usual areas involved in this process. Considering the more accurate form of infection, this result is easy to understand. The actual pathology of this is not clearly understood, or at least not fully agreed upon, by different observers, some claiming it to be a primary infection of the ganglion cells of the anterior horns, and others due to a diffuse form of myelitis, from which result the compression of the cells of the anterior part of the spinal cord, and that, as a result of this, certain of the cells become permanently atrophied from the compression. With either theory it is well accepted that the meninges may be affected, as well as the deeper portions of the cord, to a certain degree in some of the cases. The amount to which this involvement takes place in different cases must vary and explain the variation in some of the symptoms which occur both in sporadic and in the epidemic forms.

This corresponds with the clinical side of these cases. The initial fever was more pronounced and prolonged than is usually found in a sporadic form, and the evidence of toxic effect was more decided. The distribution of the paralysis was, on the whole, more extensive. Regions not usually invaded were affected, particularly the sphincters. Hyperæsthesia, extensive and prolonged, was found in a majority of severe cases, and can be explained by the involvement of the meninges, which it is recognized does occur. In addition was the evidence of the involvement of the distribution of some of the cranial nerves, as was shown by the loss of speech and by blindness. This occasional involvement of other than the usual regions has been noticed in the other epidemics. Medin has claimed that the aberrant forms are found in epidemics, but in general character and mode of onset resemble the pure spinal type. These cases, occurring in the course of an epidemic, show their relation by the mode of onset and general symptoms, but the paralysis affects the cerebral as well as the spinal nerves. In several of the epidemics in which there

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has been the opportunity of careful observation a polyneuritis has been noted. The coexistence of this complication is well recognized.

There have been several epidemics of this affection, but it cannot be considered that a large number have been reported, considering the wide range of medical observation. The earliest mention of this is by Loctmer, who noticed its occurrence in the form of an epidemic, to which he has called attention in *The American Journal of the Medical Sciences*, in 1843.

The most extensive epidemic has been reported by Medin, occurring in Stockholm in the summer of 1887 between May and November. The same conditions were observed in this, that of the ordinary infantile paralysis with a number of cases showing unusual symptoms, or of an aberrant type. Forty-four cases were seen. They showed in the initial stage fever, which was more or less constant but mild, drowsiness, and general constitutional symptoms of toxic character before the appearance of the paralysis. Constipation was usual. In these forty-four cases there were three deaths; seventeen showed unusual symptoms. In five there was paralysis of the accessorius nerve; disturbance of speech in a few; paralysis of the tongue in one; disturbance of the voice and paralysis of the muscles of mastication in two fatal cases, and ophthalmoplegia externa in one. In a number of cases a polyneuritis was observed.

The epidemic in Rutland in 1894, reported by Caverly, was one of remarkable severity, including many fatalities, and other cases presenting a very severe and pronounced form of the disease, and extended over a large area. The first cases appeared in July, with a climax about August 1st, and a gradual decline until about October 1st, the last case appearing soon after the first of the month. The epidemic included 132 cases, which were scattered in a territory of about fifteen miles along Otter Creek, in the vicinity of Rutland. Of the 132 cases 55 were from Rutland, 27 in the adjoining town of Proctor, and 50 scattered in the farming districts in small towns in this vicinity.

There was nothing in the conditions of the climate or soil to indicate anything of an etiological nature. The summer had been particularly hot and dry; the formation is one of limestone, and the epidemic was scattered among the residents, without preference to

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the lower class, and showing no presence of unsanitary conditions. If there was any preference for the location along the water it was seen only in the town of Proctor, in which four cases seemed to be located near the river.

The cases in this epidemic were characterized by initial fever, which lasted from one or two to several days, by prominent general constitutional symptoms, including stupor, and frequently hyperæsthesia, and by the development of an extensive paralysis, which seemed to involve larger regions than ordinary cases of acute poliomyelitis. In many instances there was involvement of tracts not usually affected in this disease, as, for instance, the cerebral nerves.

Nineteen of the cases were under six years of age; nine cases occurred in adults, including one seventy years old.

Convulsions occurred in twelve. Eighteen cases were fatal. In twenty there was observed a marked muscular rigidity.

An epidemic has been reported by C. A. Alston at Fort Lincoln, S. A., in the *Australian Medical Gazette*, April 24, 1897, p. 123. In this epidemic there were fourteen cases, occurring during the months of March and April in 1895. These cases presented the usual type of the acute anterior poliomyelitis, except that, as in other epidemics, the type seemed rather more severe, was attended with greater frequency of superficial pain and tenderness, with greater prominence of initial fever, and in a large proportion of the fourteen cases with involvement of the upper extremities. In ten of the fourteen cases there was a marked initial fever; in one a disturbance of the sphincters, in two a superficial tenderness was marked.

Other points of interest in this epidemic were that severe exertion seemed to have preceded the attack in two cases. In one there was involvement of the facial nerve, which was also seen in the Stockholm epidemic, and in two instances two children in the same family were attacked. With the exception of one the involvement of the parts paralyzed was not general, but was confined to one or more extremities, although in four cases it was hemiplegic.

The Cherryfield series are probably well known, occurring recently and reported by Dr. Taylor, of Philadelphia, who was in the vicinity at the time. This series of seven presented one fatality, and in one instance two children in the same family were attacked. This epi-

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demic was rather closely limited both as to its area and time, but in other respects did not present special characteristics distinctive from others.

An epidemic reported by W. Pasteur in the *Transactions of the Clinical Society of London* (page 143) occurred in seven members of the same family early in July of 1896. These presented in common the symptoms of a primary initial fever, followed in three cases by a distinct paralysis; in others by symptoms of spinal cord or meningeal involvement, but without permanent paralysis. Inasmuch as these occurred in the same family within a short time, and with the same mode of onset, he regarded them all as belonging to the same type of disease, but of different grades of severity. The first case followed distinctly the type of the ordinary acute anterior poliomyelitis, both in its mode of onset and in the subsequent paralysis. The second showed involvement of the cranial nerves, which has been observed, however, in other epidemics.

A point of much interest in these epidemics lies in the question of their identity with the sporadic type. At present we have no bacteriological evidence which is of aid in determining this, and we must rely on the clinical side of these cases. In mode of onset, cause of the disease, and distribution of the paralysis, the milder cases of the epidemics correspond so closely that there is hardly room for question, and particularly the condition found in the later stages in the paralyzed parts is identical, and cases could not be differentiated as to the class under which they originally came. Whether the lesion in the two instances is produced by the same organism is not known, but that the lesion is the same is clear, and it is not necessary to look far for analogies in which the same lesion is produced by organisms not identical. The severe and extensive paralysis constitutes one of the distinctive characteristics of the epidemic form, as would be expected in a period of intense germ activity; but, on the other hand, there are occasionally seen severe types of this affection corresponding to the cases met with in these epidemics, and resembling these in the severity of their mode of onset, as shown by the degree of infection, being attended by a prolonged fever with toxic symptoms, and also in their extensive distribution of the paralysis. This paralysis usually involves a large portion of the body, perhaps lower extremities, one of the upper extremities, and a portion of the trunk-

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muscles, or even a portion of all four extremities, and serves to more clearly show the identity of these two forms.

The detail of treatment of these cases is too extensive to be taken into consideration in this article, but it will bear mentioning in brief. It is a question of the greatest importance, for the outlook of these cases is not promising at its best, as there must necessarily be left, even after the most improvement which can be hoped for is obtained, a marked degree of loss of power. The amount of muscle-control which is regained is frequently remarkable, but there are left regions of the body and groups of muscles which regain either but a little of their lost power or else none at all. It becomes, therefore, of the utmost importance to utilize to the greatest degree all possible power which can be restored, and in this connection can be considered what might be called the late treatment of conditions found in this affection.

1. This may be considered, as in the first place, an attempt to bring about as far as possible return of muscle power by all such methods as may promote the absorption of the exudate, and also by the development of subsidiary tracts, which it is recognized is possible now to a most satisfactory degree.

2. To utilize the improved muscles to the best mechanical advantage; and under this head can be considered the transplantation of a muscle and tendon, that they may become antagonists, and also so placed that mechanically they will be acting in such a way as to produce the most effectual mechanical action.

There is, unfortunately, a rather prevalent opinion that the treatment of this class of cases is hopeless in the extreme, and that the amount of improvement which may be expected must occur early in the course of the convalescence, and that further improvement must not be expected. Fortunately, however, this opinion is not correct, but it is certain that one may hope for improvement, and even for the return of muscle power, in some instances for many months after the onset of the paralysis. The reason of this change that may take place is difficult to explain, as in the remoter stages it seems hardly possible that it can be due entirely either to the absorption of the exudate, which has compressed the ganglion cells, or to the development of subsidiary tracts; as, in many instances, groups of muscles and portions of the body may show the

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No. of case.	Age.	Sex	Date of attack.	Method and time of invasion.	Duration of period of invasion.	Fever.	Mental and cerebral symptoms.	Paralytic symptoms.	Bladder and rectum.	Peripheral tenderness and distribution.	Distribution of paralysis.	Time of first reappearance of motion.	Distribution of paralysis compared with original paralysis.	Involvement of trunk.	Locality.
I.	2 yrs. 3 mo.	Boy	Sept. 10	A.M. Flushed face, loss of appetite, vomiting, fever, coughing, choking.	6 days.	Severe.	.....	Inability to sit up, no motion in legs except 3d, 4th, 5th left toes.	Both involved, bowels 1 yr. bladder 15 months.	Both legs, formication still persists.	Back, legs, bladder, bowels.	Oct. 13, '94, moved right large toe (34 days).	Bowels, bladder, and back O.K.; slight motion in legs; walks, braces.	.....	Low, in swamp near river.
II.	4 yrs.	Boy	Sept. 1	A.M. Headache, restlessness, slight fever.	2 days.	Mild.	.....	Inability to walk, could move legs at all times.	Loss of control of bladder for 2 months.	.....	Both legs, bladder.	Walked 3 weeks from date of paralysis.	Weakness of extensors; walks with limp; toe-drop.	.....	High, on edge of swamp.
III.	2 yrs. 3 mo.	Girl	Sept. 5	P.M. Loss of appetite, fever, pain, crying, restlessness.	7 days.	Moderate.	.....	Inability to move a muscle.	Loss of control of both for 2 months.	General tenderness, still persists.	Arms, legs, back, bladder, bowels.	8 weeks, motion first in left arm.	Knee-jerks O.K.; weakness of extensors on left side; plantar flexors 2d–5th left toes; weakness right flexors; plantar flex. 4th and 5th toes.	Right scapula prominent; dorso-lumbar curved to right; muscles on right contract.; on left flaccid.	Very high, dry, near river.
IV.	3 yrs. 9 mo.	Boy	Sept. 18	P.M. Stupor, pallor, opisthotonus, great pain.	2 days.	?	Blindness 2 weeks, stupor 1 week.	Inability to walk, sit up, loss of sight.	Neither involved.	General tenderness of legs and back.	Legs, back, eyes.	?	Plantar flex. 4th and 5th toes, both feet.	.....	Low, near river, north branch.
V.	3 yrs. 1 mo.	Girl	Sept. 17	Pain in head two days, vomiting, delirium.	6 days.	Mild?	Delirium.	Inability to sit up or move legs.	Bladder.	Very marked general (persistence).	Legs, back, abdomen.	3–4 weeks motion in toes.	Both legs, l. abdomen.	Abdomen	Low, damp, near river.

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VI.	2 yrs.	Girl	Aug. latter part.	P.M. Restlessness, fever, pain, limp.	14 days.	Moderate.	.....	Inability to move right leg.	.....	.....	Right leg.	1 week.	Weakness of extensors; slight plantar flex. of 2d–5th toes; foot cold.	.....	Low, near north branch.
VII.	2 yrs.	Girl	Aug. latter part.	P.M. Pallor, loss appetite, vomiting, defecation, urination.	1 day.	Slight.	Unable to speak for 3 to 4 months.	Inability to move either legs or sit up.	Loss of control of both, bowels o.k., bladder still.	Loss of sensation in legs.	Speech, legs, back, bladder, bowels, sensation.	1 month, first in back muscles.	Weakness of extensors on right; slight plantar flex. 4th, 5th r. toes; flexion limited on left.	Contraction of right dorsal muscles.	Low.
VIII.	1 yr. 6 mo.	Girl	Aug. latter part.	P.M. Stupor, pallor, fainting, diarrhœa.	21 days.	?	Marked stupor.	Inability to stand, walk, or sit up.	Loss of both, bladder persists, bowels 2 years.	General, still present.	Legs, back, bowels, bladder.	? First in left leg.	Weakness of extensors on right; right knee-jerk absent.	.....	Low; no sewer, yard always damp; near river.
IX.	2 yrs. 6 mo.	Boy	Aug latter part.	P.M. Fever, vomiting, flushed face, eyes roll, opisthotonus.	6 days.	High.	.....	No motion left leg, partial in right; back?	Loss of control of bladder.	.....	Left leg, right in part, back? bladder.	6 weeks, first in right leg.	No motion in either small toes; left foot cold.	.....	High, dry.
X.	2 yrs. 6 mo.	Girl	July 25	P.M. Fever, pain, vomiting, crying.	2 days.	Moderate.	Speech 1 year.	Unable to move right leg, right thumb; partial motion left leg.	Bladder still persists.	.....	Speech, right thumb, right leg, left leg in part.	? In left leg first.	No motion right leg except ext. rectus and l. v. femoralis; knee-jerk absent.	Pelvis tilted. right. an. sup. sp. 1⅛ inch lower; right dorso-lumbar curved.	High, near north branch river.

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regaining of power which has been entirely absent during the interval following the attack. It is, however, a fact that by the constant employment of the passive exercises, massage, and by the supplementing of the passive work by the attempt at active movements on the part of the patient, and this seconded by such means as are directed to improve the deeper circulation of the limbs, the parts may be in a condition to respond to the best possible advantage, even at the late stages, and when improvement has once shown itself we may expect an increase to occur some time to a most satisfactory degree. Although it is, of course, useless to hope that a part long paralyzed will regain its full usefulness, yet we may expect that enough of power will return to enable the limb to be used, either alone or supplemented by some form of apparatus.

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A NEW PARALYTIC BRACE.

By J. C. PEGRAM, Jr., M.D.,
PROVIDENCE, R. I.

THERE are so many cases of so-called infantile paralysis severe enough to necessitate some sort of support for the knee, in order to render locomotion possible, in which considerable muscular power remains about the hip, with the ability to produce flexion and extension, that it has seemed possible to transmit some of that power by

FIG. 1.

means of a suitable apparatus to the knee-joint, and there produce the same motions, namely, flexion and extension, and also at the same time give a firm support to the knee by locking that joint when the weight is thrown upon it.

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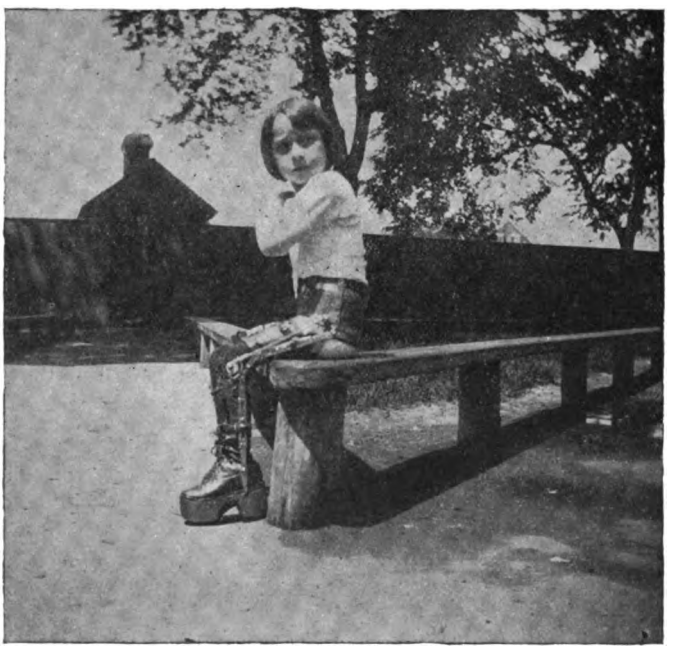
An apparatus which accomplishes these objects would allow the patient to get up or sit down more naturally, and would not necessitate the locking and unlocking of one of the many stop-joints that have been devised before the knee could be flexed. The apparatus which has been found to produce these effects consists of a pelvis-band, outside and inside uprights for the limb, with joints at hip, knee, and ankle. The pelvic-band is connected with the outside upright of the thigh, with a stop-joint at the level of the hip-joint

FIG. 2.



to prevent hyperextension of the thigh. The outside and inside uprights are connected by the ordinary posterior sheet-steel bands, and are attached to the limb by leathers; a foot-piece connects with the sole of the boot. A lever connects the pelvic-band with the outside upright for the leg, so that flexion and extension of the thigh on the pelvis of necessity produces flexion and extension of the leg on the thigh. On each upright there is an arrangement which makes it

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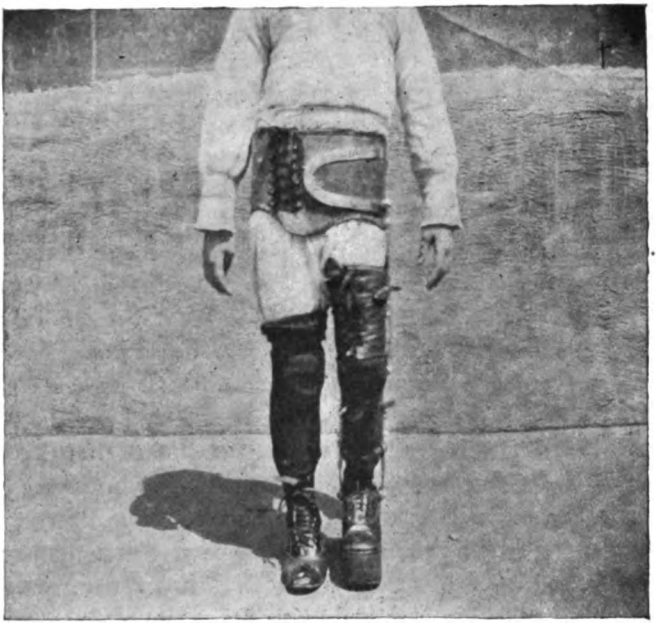
possible to obtain accurate adjustment in order to bring the joints of the brace exactly opposite the corresponding joints of the limb. The

FIG. 8.



pelvic-band is best made of heavy leather reinforced by spring-steel and fitted on a plaster cast of the pelvis.

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A NEW HEAD-SUPPORT FOR CARIES OF THE SPINE

By ERNEST BOYEN YOUNG, M.D.,
BOSTON.

In the treatment of spinal caries where the disease is between the mid-cervical region and the fifth dorsal vertebra, the position and support of the head are important, while in the upper cervical region fixation must be added to the two requisites already mentioned.

With almost every form of apparatus used for this purpose the weight of the head is borne at two points, the chin and the occiput. The natural tendency of the head is to fall forward; hence the greater amount of pressure comes upon the chin unless the head is thrown backward to an unsightly and uncomfortable degree. As a consequence of this and the thinness of the tissues over the jaw, sores are apt to result even in the most carefully fitted apparatus.

The principal objection is, however, deficiency of fixation; for if applied in such a manner as fully to carry out their intended purpose, the child is unable to open the mouth and the apparatus must be loosened during meals.

The tissues at the back of the neck and directly under the occiput are thick and not especially sensitive. It was with the idea of receiving the weight of the head on a cushion at this point, leaving the chin entirely free, that the writer devised this head-support, which is designed to be used with the Taylor brace.

The head-rest, as will be seen from the illustrations, consists of a padded U-piece which supports the weight of the head and is attached to the collar-post at a point directly under the occiput. Passing forward from the ends of the U-piece above the ears are two pads which fit closely to the sides of the head. A leather strap across the forehead attached to the ends of the pads holds the head firmly upon the U-piece. The pads prevent lateral motion; while the U-piece be-

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hind renders impossible the downward motion of the occiput which always accompanies all backward movements of the head. Forward motion is, of course, prevented by the strap across the forehead.

As is shown in Fig. 1, F is a brass or iron socket, prevented from twisting from side to side by a pin in the back of the collar-post, which slips into a slot at E. Through the upper part of this socket a U-shaped piece of steel wire, one-fourth of an inch in diameter, passes upward behind the ears, and at a level with the middle of the forehead makes a sudden bend and runs forward over the ears to a point about one inch behind the external edge of the orbit. The portions between A and H and G and D are flattened from side to side and curved to fit the head. Pieces of sole-leather, one and a fourth

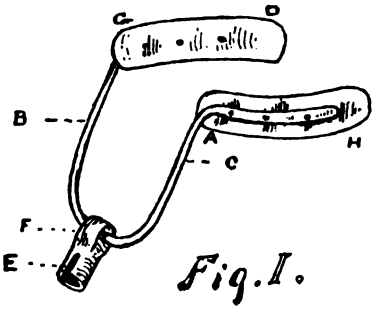

Fig. I.

inch wide, are attached to their inner sides, extending slightly beyond the buckles for the forehead-strap at H and D, and also slightly beyond the bends of G and A.

From C to B the wire is padded with saddler's felt to any desired thickness and covered with leather. This padding should exactly fit the curve of the head.

It will sometimes be found of advantage to give the bottom of the U a curve with the concavity forward; as in heads without a prominent occiput this gives a firmer support. Care must always be taken that the support does not impinge upon the back of the mastoids, or excoriations will result.

The forehead-strap is made of some pliable leather, and should be about one inch in width.

The best method of measuring for this apparatus is with some fairly pliable wire, which can be accurately fitted and then removed

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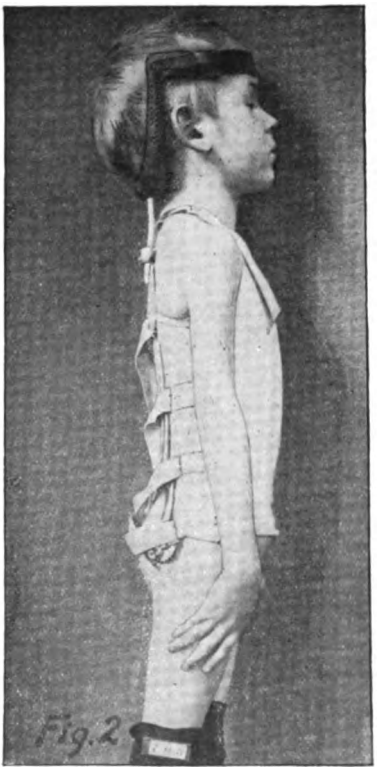
without losing its shape, the machinist making the U-piece enough deeper to allow for padding to the exact shape and size of the pattern.

If accurately fitted, it will be found necessary in applying the support to first slip the forward ends of the side pieces on to the head and then swing the U-piece downward under the occiput before attaching to the brace. The head is then pulled back over the cushion, which acts as the fulcrum, and the strap adjusted to hold it in place. The upward thrust thus applied is regulated by raising or lowering the collar-post.



It is very important that the U-piece fits closely to the back of the neck, as is shown in Fig. 2, so that the pressure falls upon the muscles at the back of the skull; otherwise it is apt to cause occipital neuralgia.

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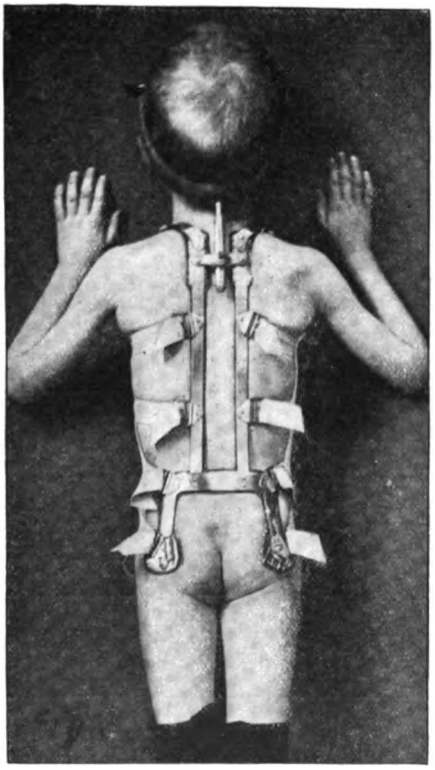
This head-support is not well adapted to children with large parietal bosses. It is also unsuitable for cases where there is a lack of intelligent care, and hence is unfit for the average out-patient case. With the exceptions stated above and some which may arise from personal idiosyncrasies, there seems to be no contraindication to its employment for the treatment of any case of spinal caries where



it becomes necessary to control the head. For such cases it offers very satisfactory fixation, the comfort of freedom of motion of the jaw, and simplicity and cheapness of construction.

The cases in the following table are published through the courtesy of the staff of the Children's Hospital and the staff of the House of the Good Samaritan.

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Case.	Age.	Sex	Age of disease.	Seat of disease.	Deformity.	Torticollis?	Previous treatment.	Time of treatment with present apparatus.	Subsequent history.
1. E. T. R.	5 years.	M.	16 months.	4th and 5th dorsal.	Slight.	None.	Plaster jacket and chin support.	1½ years.	Doing well at present time; has worn apparatus constantly since first applied.
2. K. M. M.	3½ years.	M.	6 months.	Cervico-dorsal.	Slight.	None.	Partial paralysis. Frame for three months.	1½ years.	Child in good condition at present time; has worn apparatus constantly since first applied. Ambulatory treatment for six hours daily.
3. H. C. G.	7½ years.	F.	Unknown; some months.	Cervico-dorsal.	Slight.	Present.	Brace with Thomas collar tried without success.	1 year.	Did well in hospital; but poor care outside made change of support seem best.
4. G. W.	2 years.	F.	Unknown.	High cervical.	Slight.	Present; not reduced by bed treatment.	Bed with head extension.	4 months.	Did not do well; subsequent treatment not fully carried out.
5. K. S.	6 years.	M.	4 months.	Cervical.	Slight.	Present.	Deep cervical abscess. Recumbency for six weeks.	1 year.	In excellent condition; has worn apparatus constantly.
6. J. N.	10 years.	F.	4 years.	4th to 8th dorsal.	Much.	None.	Treated with plaster jacket and jury-mast two years; brace one year; no apparatus one year; paralysis at entrance. Bed treatment in hospital two and one-half months.	6 months.	Doing well when last reported, about six months after application of apparatus. Able to walk.
7. McF.	6 years.	F.	1½ years.	High dorsal.	Considerable.	None.	Brace and head support one year. Deformity increasing.	5 months.	In excellent condition; has worn apparatus constantly.
8. M. A. H.	6 years.	M.	7 months.	3d and 4th dorsal.	Considerable.	None.	None.	14 months.	In excellent condition: has worn apparatus constantly.
9. E. P.	3 years.	M.	5 months.	6th and 7th dorsal.	Considerable.	None.	None.	6 months.	In good condition.

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A NEWLY MODIFIED SPLINT FOR KNOCK-KNEE AND BOW-LEG.

By JOHN DANE, M.D.,
BOSTON.

The number of forms of apparatus for the correction of bow-legs and knock-knees is already so large that in presenting a new one it is necessary to state as quickly and plainly as possible what advantages can be claimed for it. This can possibly best be done by considering for a moment some of the difficulties found in applying the splints now in common use. Such splints consist essentially of a single rigid upright running from the sole of the foot to the upper part of the thigh. To this the leg is drawn inward or outward, as the case requires, by a series of straps and buckles. This description applies equally well to the braces made by the instrument-makers; for though they are provided with two uprights, one on each side of the leg, but one can be used against which to pull.

The disadvantages of such braces are of three kinds: 1. The points of counter-pressure above are often so small that they cut into the soft parts, which renders them both insecure and uncomfortable. 2. The straps and leathers, which necessarily encircle almost the entire leg, must cause a series of band-like constrictions. 3. It is very difficult with them to prevent a slight flexion of the knee. Such a bending having taken place, the limb can at once be made to lie parallel with the splint without the least pressure from the straps, thus doing away with all the correction forces that should be directed against the deformity.

Turning now to the new splint—much more easily understood from the picture (Fig. 1) than from any printed description—it will be seen that the two light uprights are placed in front and behind the leg instead of on the sides. In this way flexion of the knee is

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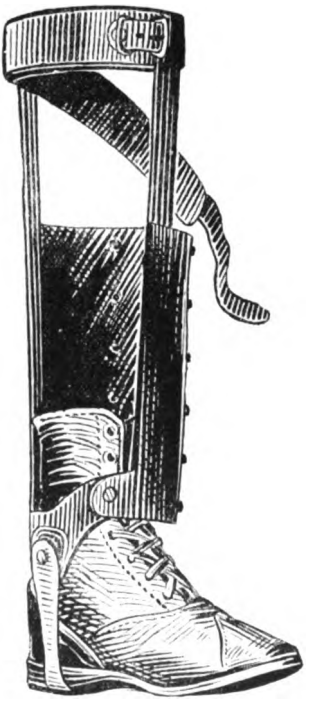
easily prevented. These two uprights are joined together by two half circles of thin steel three-fourths of an inch wide, the lower one at the level of the malleoli, the upper as high up the thigh as possible. These give a wide base for counter-pressure and are very comfortable. Practically it was found best to curve the lower one upward a little in front (as shown in the figure), to allow of dorsal

FIG. 1.



flexion of the foot without pressure against the iron. The splint is united to the shoe by means of a flat piece of steel, fastened to the lower band by a single pivot joint, and extending down to the sole, where it is bent at a right angle and nailed to the heel. In this way the whole apparatus is prevented from slipping around the leg in a circular manner. Pressure is made upon the deformity by means of two flaps of leather fastened to each upright, and tightened at their overlapping edges by a lace-line running through a series of

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eyelets. As these leathers only half encircle the circumference of the leg, they can cause no injury from constriction. The necessary changes in the leather to adapt the splint for knock-knee will be so evident that a description of them is omitted.

It cannot be claimed that this splint is original. In the *Revue d'Orthopédie* for 1892, vol. iii., in an article entitled "Du Traitement orthopédique des Cagneux," Dr. Henri Martin, of Lausanne, speaks of a similar splint, but without the connection with the shoe, which he says was used by Venel and his pupils in treating knock-knee nearly one hundred years ago. He appears, however, never to have so modified it as to use it for bow-legs, and, owing to its lack of connection with the shoe it was hard to keep in place. He says himself that it is easily displaced by the movements of the child, and speaks of its being, therefore, necessary to keep it under constant observation, and even to reapply it several times a day.

The new splint is not exactly like this in any single part; each detail has been somewhat altered and additions made. I hope the resultant is a simple, easily adjusted, and powerful splint, that may again find favor with orthopedic surgeons.

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A BIVALVE PLASTIC SPLINT FOR POTT'S DISEASE.

By HENRY LING TAYLOR, M.D.,
NEW YORK.

The advantages that may fairly be claimed for the fixed plaster jacket in the treatment of Pott's disease are:

1. Small expense.
2. Ease of application, and,
3. Immunity from meddlesome interference.

Its disadvantages are:

1. Uncleanliness.
2. Liability to produce excoriations.
3. Lack of adjustability and of precision.

Where intelligent home co-operation can be secured, as usually in private practice, a properly applied and adjustable steel leverage supporting apparatus is preferred by the writer, in common with most American orthopedists. In dispensary practice, on the other hand, especially where the numbers are large and the facilities limited, properly adjusted plaster splints may serve an excellent purpose.

In regard to the mechanical action of plaster splints, the writer finds himself in accord with Bradford and Lovett, who make the following statements in their standard work (*Orthopedic Surgery*, pp. 60, 61, 71): "The undoubted beneficial effect of plaster jackets is due, not to the separation of the affected vertebræ, but to a fixative support in an improved position. In short, the plaster jackets afford an excellent antero-posterior support." And, again: "Unfortunately, however, the plaster jacket does not of itself, by its hold on the thorax, maintain a continued extension, but the jacket and thorax so adapt themselves to each other that active suspension ceases. The jacket, however, does act as an antero-posterior support until it becomes loose and inefficient."

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It is a serious mistake to suppose that a clear conception of its mechanical action and sufficient technical training are not needed in order properly to apply a jacket. The fact that these are so widely disregarded may, however, account for many disappointments in practice and the curious fact that, in spite of an enormous accumulated experience, we have no adequate tabulation of final results of treatment. This may also help to explain the small progress made in technique since the introduction of the method.

If the plaster jacket acts like a steel splint, simply as a leverage mechanism, similar principles should be regarded in its application. The posterior half, at least, should be rigid, and force must be steadily applied from behind forward to the affected region of the spine, and in front from before backward at the upper and lower regions of the trunk.

In order to apply this pressure most efficiently and comfortably, thick strips of felt about an inch wide are fitted to the back, either side of the spinous processes, before the plaster is applied, distributing the pressure as is done by the pad plates of the steel apparatus or by the padding of a horse's saddle, without impinging upon the spinous processes, which are poorly adapted to bear pressure.

If, for the sake of cleanliness, the jacket is made removable by being split in front, it soon loses its rigidity and consequently its power of support, and this is not to be recommended while disease is active. If, however, the jacket is cut down in each axillary line, so that it is divided into an anterior and posterior half, each half will retain its shape and rigidity, and may be firmly joined by webbing and buckles; at least four sets are needed on each side, or one side may be joined by a leather hinge. When the jacket is cut down a strip of felt should be laid across the upper and lower end of the anterior piece to increase the leverage, and one-half inch or more should be removed from each lateral edge to allow for shrinkage and straightening of the body. The fact that the two valves can be readily approximated after this excision shows that, as ordinarily applied, the leverage is insufficient.

Instead of using bandages and suspension, the bivalve splint may be made as follows: A paper pattern of the posterior valve is made from the patient's back, allowing one inch extra around the edge to be folded back. From this pattern eight or ten thicknesses of

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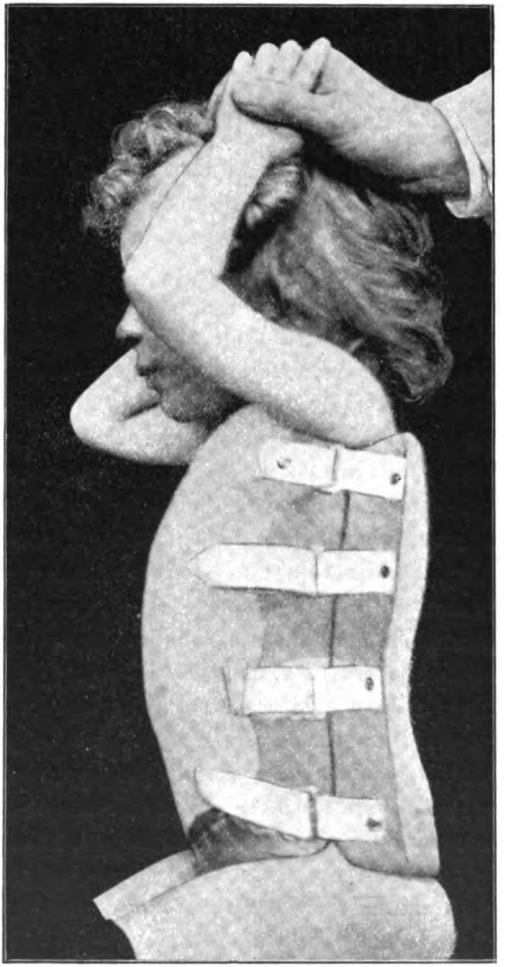
crinoline are cut of the same size and shape. The patient being supported face downward on a rest under the pelvis, and another under the upper part of the sternum, the crinoline sheets are dipped

FIG. 1.



into plaster cream in a large flat pan and applied to the back, the felt pads being in position; the edges are folded back for greater rigidity, and the whole is carefully moulded to the patient and allowed to set,

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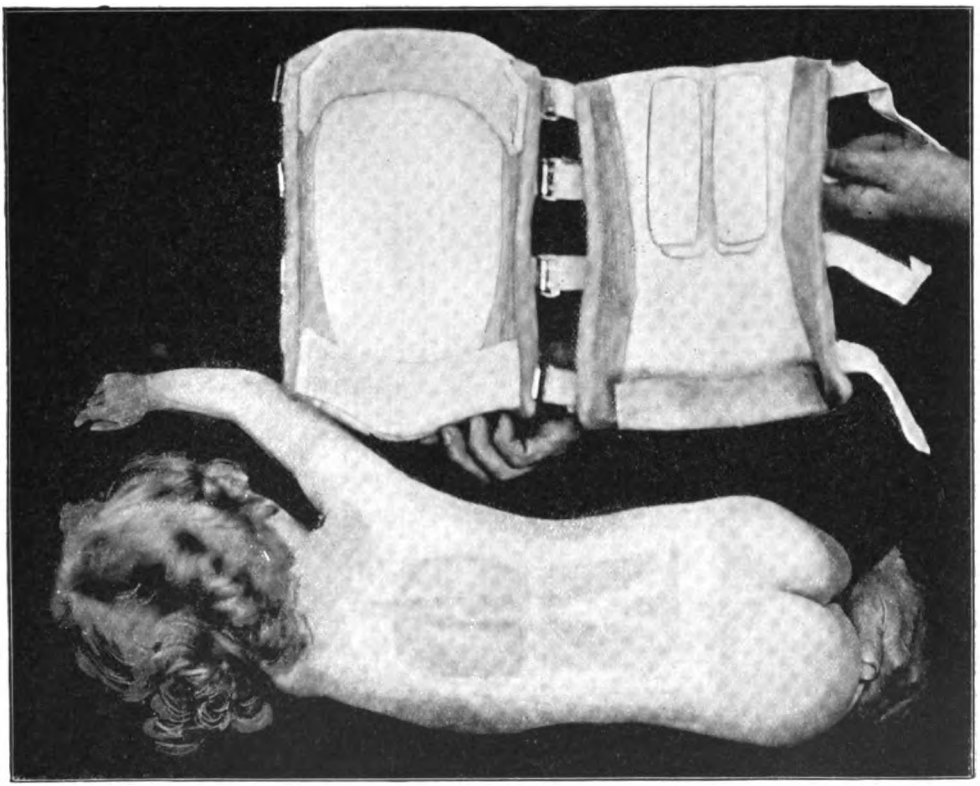
after which the patient is turned on his back, and the anterior valve is made in a similar manner.

The jacket should be made firm and rigid, especially at the edges, and should reach in front from the pubes to the top of the sternum. Such an apparatus is shown in Fig. 1; it is rigid, removable, and adjustable, and brings the pressure to bear in definite areas selected

FIG. 2.



with regard to its mechanical action. The splint may be removed to cleanse the back or to note its efficiency, taking the impressions made by the felt pads either side of the spinous processes as a guide. If more leverage is needed, the felting may be reinforced, or the depth of the casing reduced by paring the lateral edges. In other words, the jacket has ceased to be mainly a casing, and has become

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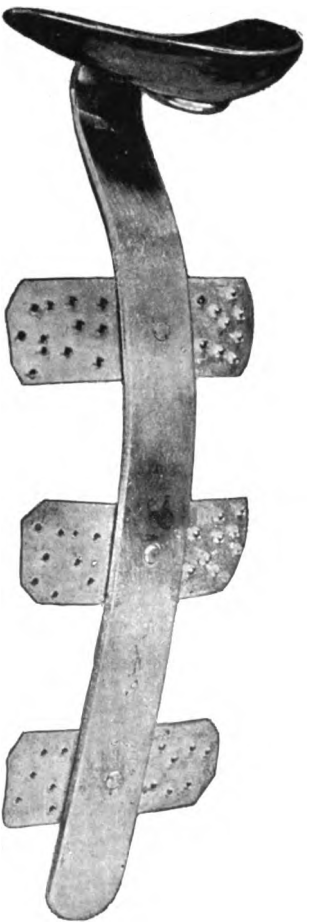
a mechanism under the surgeon's control, and capable of being manipulated to produce definite mechanical results.

Whatever the mechanism employed, it should never be forgotten that what is mainly intended by its action is to promote the general

FIG. 3.



and local hygiene of the patient; that it is inherently and necessarily imperfect, and that periods of recumbency and other hygienic measures are to be prescribed as indicated. The patient requires general and special management progressively modified to suit his needs;

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his treatment must be both surgical and medical. If the disease is in the lower lumbar region, he should be kept recumbent on a special frame, with or without an apparatus. If in the cervical or upper dorsal, the leverage should be increased by adding a head-support. This may be furnished by a chin-cup resting on a steel bar or bars incorporated in the anterior half of the splint (Fig. 3). If necessary, an occipital or occipito-frontal rest may be supported from the posterior valve.

In conclusion, it may be remarked that the terms "jacket" and "head spring" seem infelicitous and of evil influence. As old Percival Pott puts it: "Many instances are producible in which our conduct is in great measure regulated by the language which we use." A "jacket" is a covering, but the thing we use in the treatment of Pott's disease is, or should be, a splint, a tool, a mechanism, and only incidentally a covering.

A "spring" connotes elasticity, vibration, which are the qualities that should be relentlessly eliminated from a head support, and which make the jury-mast such an imperfect contrivance.

If we would think of the plaster cylindroid as a brace or splint, and the chin-rest as a support, and so designate them, our mechanical ideas would be clearer and our methods more workmanlike and efficient.

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SOME EXPERIMENTS WITH THE CELLULOID BANDAGE.

By AUGUSTUS THORNDIKE, M.D.,
BOSTON.

For the past two years many attempts have been made here, as well as in other places, to use celluloid as a substitute for leather in making jackets and splints. Dr. C. S. Page, in the orthopedic clinic at the Boston Dispensary, has applied jackets made upon plaster casts by bandaging the cast with a gauze bandage soaked in celluloid previously dissolved in acetone.

In Dr. Bradford's office jackets have been made by applying to the cast strips of celluloid softened by immersing in acetone until the strips become wrinkled, then stretching them smoothly over the cast. This method is used by Vulpius, in Germany.

The celluloid may also be dissolved in acetone to the consistency of a starch paste, and applied to a layer of gauze bandage like silicate. I find that eight or ten coats of this paste are necessary to give sufficient firmness, but very satisfactory jackets can be made by this method. The chief objections to it are the length of time required to dry each coat of the paste, and the shrinking, which is considerable.

I have lately tried the following method. Sheet celluloid comes in sheets of varying thickness, forty inches long by twenty inches wide. These are cut lengthwise into strips three or four inches wide, rolled like a bandage and fastened by a rubber band. They are then softened by exposing to the vapor of acetone in a tight jar until soft enough to adhere slightly. They are then applied like a roller bandage, and to insure the adhesion of the overlying layers the acetone-celluloid paste is painted on as the bandage is applied. The method is new and needs further trial. Flat-foot plates and other splints can also be made by this method. The bandage dries in about half an hour, and may be applied directly to the limb.

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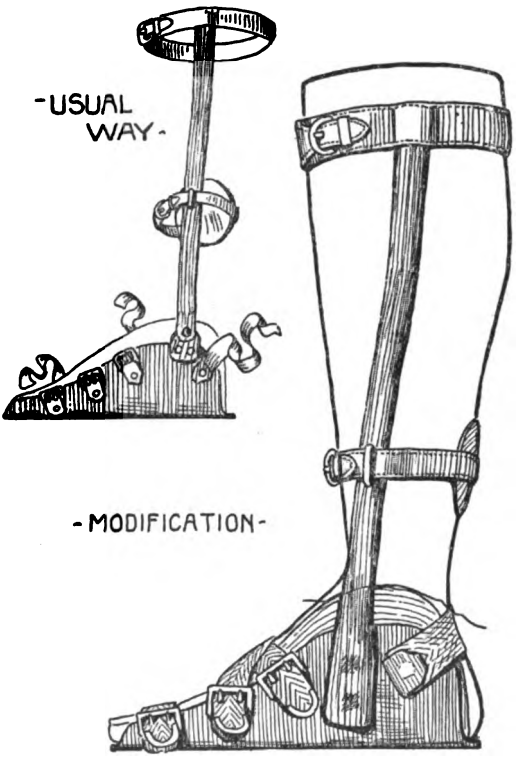
A MODIFICATION OF THE TAYLOR OR JUDSON CLUB-FOOT BRACE.

By ANSEL G. COOK, M.D.,
HARTFORD, CONN.

In both the Taylor and the Judson club-foot braces the upright extends vertically down the inner side of the leg and joins the foot-piece at a point opposite the internal maleolus.



A better grasp of the foot can be obtained, and leverage more directly applied, by carrying the upright *obliquely* down the inner side of the leg, joining the foot-piece at a point opposite the arch of the foot.

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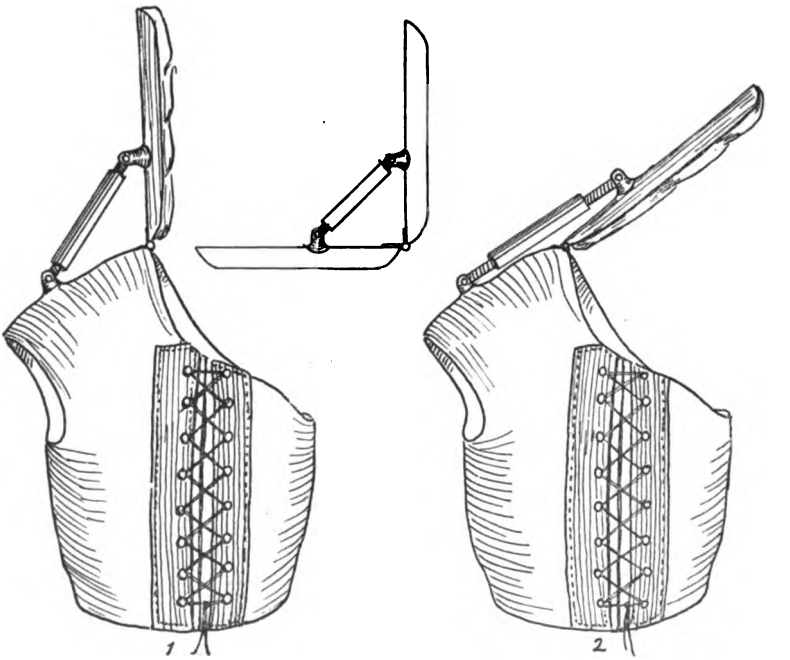
A SIMPLE APPARATUS FOR THE TREATMENT OF TORTICOLLIS.

By ANSEL G. COOK, M.D.,
HARTFORD, CONN.

I HAVE recently operated on three children, aged, respectively, two and a half, four and a half, and six years, by making a longitudinal incision from three-quarters to one inch and a quarter



in length (the longer the better) directly over the shortened tendon at its lower extremity. The tendon was hooked up, examined, and

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cut over a grooved director. The edges of the cut skin were then retracted, and a good view of the bottom of the wound was obtained.

As the extension of the head was continued, and the tendon sheath and other bands of fascia came to the surface, they were examined and cut, either over a director or with a pair of blunt-pointed scissors.

The cut in the skin being longitudinal, there was no tendency to gaping of the wound, but the edges were brought into apposition with fine catgut sutures. The scar was insignificant—almost nothing.

The after-dressing consisted of a felt pad over the shoulder to which the head inclined, a felt pad under the opposite axilla and extending well down over the chest, and over all a plaster-of-Paris bandage.

Incorporated in the plaster, with one end resting on the pad on the shoulder and the other padded and bandaged to the side of the head, was an ordinary Day's hinged elbow splint, with screw extension. The dressing proved comfortable, efficient, and easy to manage. All the patients made good recoveries.

In the third case, where I had become more expert and cut more bands of fascia, the head was practically perfect before the patient left the table, and the apparatus was only worn for two weeks, after which daily exercise with the lateral curvature extension apparatus was all that was necessary to complete the cure.

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OBSERVATIONS UPON TUBERCULAR JOINT DISEASE IN COLORADO.

By GEORGE B. PACKARD, M.D.,
DENVER.

It is well known that Colorado is the home of a large number of people who are suffering from pulmonary tuberculosis or who have already recovered from this disease. However much we prefer to believe otherwise, this fact is undeniably true, viz.: that a large percentage of the adult population is tubercular. And, consequently, it would be very natural to suppose that a large number of their offspring would develop tuberculosis, notably tubercular joint disease, as this is the form most likely to occur in children.

I shall not quote statistics at this time to prove the assertion, but I am confident, from general observation, that such is not the case.

It has fallen to my lot to see quite a number of cases of tubercular joint disease in Colorado, and also to have had a somewhat extended experience with this class of cases in the Eastern climate. As a result of this comparison, I am satisfied that the percentage of children suffering from tubercular joint disease in Colorado is much less than in moist climates, notwithstanding the fact that a much larger proportion of the parents have a tubercular history.

The fact that tubercular joint disease is not more common in Colorado in children corroborates the non-hereditary theory of the disease. I believe it is extremely rare for the tubercle bacilli to be transmitted from parent to offspring. The problem we have to meet is in many cases an inherited constitutional or local weakness, and consequently a diminished power of resistance to the specific organism.

I believe the climatic conditions in Colorado are an important factor not only in overcoming this inherited tendency or weakness,

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but also in modifying the specific organism in such a way that it becomes less active.

The climatic conditions surrounding these patients in this dry and elevated region and in the low, humid climates are entirely different. The favorable surroundings in Colorado are undoubtedly a strong factor in the prevention of this dreaded disease. This most favorable environment also has a marked effect upon the course of this form of tuberculosis as well as that of pulmonary tuberculosis; in fact, in the latter disease I am inclined to think we are apt to attribute the improvement too much to the local effect of certain climatic elements and too little to the general effect produced by the exhilarating mountain air.

In the management of these cases under efficient mechanical treatment I have been impressed by the absence of suppuration and the freedom from active symptoms. I am aware that in any locality acute symptoms and formation of abscess are not looked for under good mechanical treatment, but my observations in the East would lead me to believe that these symptoms are much more common in that locality than in the Rocky Mountain region; in fact, I can hardly recall a case where suppuration has occurred in this climate, except where the patient has been neglected, or the general condition greatly reduced from some other cause, or where they have been subjected to the cruel manipulations of the so-called "osteopath."

I have had quite a number of cases of suppurating joint disease come under my care, both in children and adults; some of them residents of Colorado, without previous mechanical treatment; others from Eastern localities, some of which had received mechanical treatment and were provided with well-adjusted supports. Marked improvement, particularly as regards suppuration, was soon observed in almost every case. In the first class the mechanical appliance supplementing the favorable climate was sufficient to arrest suppuration in nearly every instance. In the second class the favorable climate supplementing the local treatment was sufficient in most cases to arrest suppuration.

I have also been impressed by the inactivity of the disease in cases that have not been under treatment. I have had occasion to observe a number of cases that were undoubtedly tubercular, but for various reasons were not under any treatment. The only benefit

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they received was that derived from the climate. It has been a matter of surprise to see how little activity of disease was present, how little complained of by the patient, and how long suppuration had been delayed. It seems as if the disease were held in a state of arrest by the effect of the favorable surroundings on the general condition of the patient.

My statements in regard to the development of tubercular joint disease in children would not apply to adults, especially at middle life or later, and for various reasons. As already stated, quite a large per cent. of the adult population have pulmonary tuberculosis, either in an active form or in a state of arrest. It would, therefore, be a very easy matter for a joint or the spine to become involved at any time from dissemination of tubercle, and especially so as the power of resistance would be lessened with advancing age, and as mining is a prominent industry in that region, accidents are more frequent, especially of the spine. My experience confirms this theory, for, of the cases of tubercular joint disease that I have seen in this region a much larger per cent. have been in adults than is usually observed.

Notwithstanding these facts regarding the existence and development of this disease in adults, the course and progress is favorably modified by the climate as regards acute symptoms, suppuration, and arrest of disease. This is an important fact, for we all know how serious suppuration is in the tubercular joint of the adult.

The results obtained in this climate in tubercular joint disease are much better than are usually seen at low altitudes. The duration of the disease is shortened and the functional result much better. I have frequently found myself giving too unfavorable a prognosis in these cases as to duration of disease and ultimate functional result, my opinion being based upon my experience in treating joint disease in a locality with less favorable environment. It is very unusual to see a case under treatment go on to disintegration of the joint, prolonged suppuration, and followed by amyloid degeneration of some of the internal organs, such as I have witnessed many times in the Eastern climate.

It may be asked what are these conditions of climate that so favorably fortify the individual himself and yet weaken the microorganism which threatens to attack the joint of the weakened child or has already invaded it.

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In most of our text-books on the treatment of tubercular joint disease the importance of fresh air and sunshine is emphasized.

Some of the characteristics of the Colorado climate are sunshine, pure air, dryness, rarity of atmosphere, a moderately cool atmosphere, dry, sandy soil, and a small amount of precipitation. We should expect these climatic conditions to have either a direct or an indirect favorable influence on the course of tubercular joint disease. We all know the influence on pulmonary tuberculosis. The effect of sunshine is very great; it is not only exhilarating and cheering, but it allows the patient to spend a great portion of the time out of doors in the pure air. Figures show that there is an average of 320 days of clear weather in a year in this climate. When we add to this important element dry air, a sandy soil, and a small amount of precipitation—the average being less than fifteen inches per annum, while in Boston it is nearly fifty inches—it is very evident that our patient can spend most of the time in the open air, constantly receiving its invigorating influence. The benefits to be derived from this climate are not limited to any particular time of the year, for it is an all-the-year-round climate. The winters are no exception to the rule, for they are mild, and the constant sunshine so modifies the air that the patient can be out most of the time. The summers are comparatively cool, dry, and free from hot, sultry nights that are present in moist climates and are so debilitating to children already reduced by joint disease. Rarity of atmosphere is one of the characteristics of this climate that may not have any direct effect on the tubercular joint, but indirectly the influence may be felt. It may be the means of opening up unused portions of the lungs that are so liable to be affected in this class of cases, and thereby improve the general nutrition. The beneficial effect of these combined elements of climate on the organism struggling with germs, whether in the lungs or the joints, cannot be questioned. The tubercle bacilli also becomes a much less harmful agent after exposure to the dryness and sunshine of this altitude.

Another important point that should be considered in this connection is the liability of these cases to develop pulmonary tuberculosis at any time. This would be a serious complication and is an important reason for placing these cases under the most favorable conditions possible. Nothing could prove more beneficial as a preventive meas-

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ure to pulmonary complications than the climatic conditions to be found at a moderately high altitude.

I believe in the past we have been inclined to overlook the importance of the general treatment, or rather the conditions of climate in its effect upon this form of tuberculosis. It may not be as necessary in the majority of these cases to make such radical changes in regard to climate as in pulmonary tuberculosis, yet I think the subject is worthy of consideration, and I believe that in the future this part of the treatment will receive more attention, and the local treatment in tubercular joint disease that has proved so successful will be supplemented by a judicious climatic environment.

These suggestions with reference to tubercular joint disease in Colorado are not only a matter of personal opinion, but are indorsed by the best observers who have practised medicine and surgery in this region for many years, and I feel that my opportunities of seeing this form of disease to a considerable extent, both at sea-level and at an altitude of one mile or more above sea-level, justify me in drawing these conclusions.

DISCUSSION.

DR. SHAFFER said that the conclusions reached by the author should be emphasized. Those who had studied joint disease at the sea-level must be impressed with the necessity for having a country branch to orthopedic hospitals. An analysis made by Dr. F. E. Solly, of the tubercular inhabitants at Colorado Springs, showed that a very small percentage of children born of the people developed tubercular joint disease.

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INFLAMMATION OF THE POST-CALCANEAL BURSA ASSOCIATED WITH EXOSTOSIS.

By CHARLES F. PAINTER, M.D.,
BOSTON.

During the past eighteen months I have seen in the Orthopedic Clinic at the Boston Dispensary six cases of this affection, and through the kindness of Dr. Goldthwait two other cases in private practice. All of these cases, with one exception, had the exostoses in addition to the bursal inflammation. The frequency of the occurrence of this condition in a series of perhaps two hundred cases of painful affections of the feet of one sort or another suggested the possibility of the condition having been overlooked in certain cases where anti-flat-foot treatment was of no avail.

Certain facts observed in the etiology and certain features of the clinical history have suggested the possibility of a constitutional diathesis being at the bottom of the whole matter. If the conclusions from these facts are correct as to etiology they have an important bearing upon treatment.

Patients suffering from this condition present the following symptoms: They complain of pain at the insertion of the tendo Achillis and along its course for a variable distance. All motion of the feet is painful, especially dorsal flexion, and is more or less restricted. Walking in the bare feet is impossible in some cases, and the gait is that of an extreme valgus. There is sometimes a valgus associated. On either side of the tendon, filling up the lateral fossæ, is a swelling, which may be dense, firm, non-elastic, or it may be soft, but is always tender to pressure. Pain may also be referred to the plantar surface of the os calcis, which may also be tender to pressure. The swollen area is usually slightly hyperæmic, and the surface temperature is increased.

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In this situation a process giving rise to such signs and symptoms could be located in the tendon sheaths, in the bursal sac, or in the bone. Schüler and Rössler have established the existence of this post-calcaneal bursa as a normal anatomical structure from an investigation on some three hundred cadavers. There is a similar though smaller one situated beneath the os calcis, separating it from the plantar muscles. The walls of the bursæ are normally quite thick, and the serous surfaces are thrown into rugæ. Heinecke was the first to describe these structures anatomically. Nancrede has shown that cartilage is normally present in the anterior wall of the post-calcaneal bursa.

A study of the literature brings out a number of cases of this sort, or analogous to them. Rössler reports nine cases, presenting symptoms like those just mentioned, in which he believes that long-continued pressure had caused an inflammation and consequent thickening of the periosteum over the os calcis.

Frankë believes the process to be primary in the periosteum; he also reports cases following influenza.

Rosenthal found a neuroma in a patient with these symptoms which was being pressed upon by the tendo Achillis. Raynard has reported a few cases of acute suppuration in the sheath of the tendo Achillis following certain general infections, showing that such tissues are vulnerable to infection.

Kirmisson also reports two cases of peritendinous inflammation about the Achillis tendon. One case was suffering from gonorrhœal synovitis and the other from multiple fibromata, one of which was beneath the tendo Achillis. The first one had an excess of uric acid in the urine and nodosities at the metacarpo-phalangeal joints.

Da Costa reports eight cases of inflammation of this bursa. The bursal sacs contained osteophytes, some of them tipped with cartilage. They occurred in both the anterior and posterior walls of the bursa.

In the above cases the causes assigned have been trauma, gonorrhœa, syphilis, rheumatism, influenza, sciatica, tuberculosis of os calcis, scarlet fever, uric-acid diathesis, etc.

A condition comparable to this, in a way, is that described by P. Busquet, in which he calls attention to the painful exostoses on the dorsal surfaces of the second, third, and fourth metatarsals,

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occurring in men whose duties require them to walk long distances. He divides the cases etiologically into three groups: one where the trauma from walking is direct, one where it is indirect, and one where it is dependent upon a diathesis.

PATHOLOGY. In three of the cases which I am about to report the bone removed from beneath the tendo Achillis has been examined histologically, with the following results: The marrow spaces are filled with a young granulation tissue in which are numerous plasma and lymphoid cells, and this is plentifully supplied with new-formed bloodvessels. The cartilage over this is the normal hyaline variety. The trabeculæ are surrounded by osteoblasts. The subungual exostoses present the same appearance under the microscope. This would seem to indicate an inflammatory process. Grossly, at the time of operation, a profuse capillary hemorrhage has been noted, as though the tissue were engorged with blood, and this would also suggest the venous stasis of inflammatory changes.

CASE I. The patient (C. H. H.) was twenty-seven years of age, a hotel clerk by occupation. He has had trouble with his feet for four or five years, complaining of pain along the tendo Achillis. He was wearing bronze flat-foot plates, applied three years ago. There was no appreciable valgus. He had not been at all relieved by the use of the plates. There was no rheumatic, syphilitic, or gonorrhœal history obtainable. There was marked thickening, which was tender to pressure on either side of the posterior portion of the os calcis, suggesting a bursitis or an exostosis. The x-rays revealed nothing. He was admitted to the Carney Hospital, and was operated upon June 14, 1897. Through a two-and-a-half-inch incision, parallel with, but a little in front of, the tendo Achillis, a bursal sac was dissected out which was thickened; this was opened, and no fluid found within, but in place of it a small amount of viscid, myxomatous-looking tissue jutted out from the walls of the sac anterior to this, and projecting from the posterior surface of the os calcis was a rough line of bony spicules. These were curetted off and the wound closed. On June 18th he was discharged from the hospital, and since that time has been under observation. For a time he experienced some relief from the operation, but this has not been permanent. He was not sufficiently encouraged to submit to opera-

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tion upon the other foot; he also complains now of pain on the plantar surface of both heels. This patient was seen walking upon the street recently, and, so far as the gait was an indication, he was apparently well.

CASE II. This patient (G. R.) was twenty-one years of age, employed in the print works as a dyer, where he has been obliged to be exposed to changes of temperature in going from a hot, moist atmosphere into cold surroundings. For ten years he has had pain in his heels to such an extent that he has lost a considerable amount of time from his work. Three months ago he was obliged to give up entirely. He is a large, heavy man, who walks with a marked limp in both feet, using two canes. The arches of his feet are strong and apparently efficient. The calves of his legs are small in proportion to his muscular development elsewhere. On either side of both tendo Achilles are marked thickenings, which are very tender to pressure; he is also tender beneath the point of the heel. The x-ray was not employed. He cannot walk a step in his bare feet without the use of his canes. He was operated upon through incisions similar to the ones employed in the previous case, except that the incisions were made on either side of the tendon in order to get at the bony thickening more readily. There was considerable fluid in this bursal sac, the interior of which was thrown into folds, but there were no osteophytes seen; beneath these was a diffuse bony projection, with two or three sharp spines coming from it. This was removed readily with a heavy chisel. Fourteen days later he was allowed to get out of bed, and could walk in his bare feet without pain, except for a trifling soreness, without cane or crutch. Two days later he was discharged. Since the operation he has been able to return to his work gradually, having had two or three attacks of considerable soreness about his heels, but by means of massage, bathing, and moderate exercise he has now, May 1st, so far recovered that he can walk four or five miles without discomfort, and is able to return to his old employment. Examination with the fluoroscope does not show any exostoses.

CASE III. This patient (P. L.) was twenty years of age, a loom-tender. He complains of pain under the point of the heel

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and along the tendo Achillis, which followed the use of a bicycle, the pedals of which were too long; consequently he was obliged to use toe-clips to keep his foot upon the pedal, always riding with his foot plantar flexed. He always rode in high shoes. This would bring the counter of the shoe in contact with the skin over the insertion of the tendo Achillis throughout the whole circuit of the pedal. He has had this trouble for twenty months. He states that his father had chronic rheumatism which laid him up for two years before his death, which apparently resulted from cancer of the throat. He also states that he has been obliged himself to work where his feet were wet a good share of the time. For this condition, which had resulted in such a degree of plantar flexion of the foot as to compel him to walk on his toes, he had a tenotomy of his tendo Achillis performed in August, 1897. At the same time the bursal sac beneath the tendo Achillis was opened, and kept open, being allowed to close four months later. He was then permitted to get up, but, the condition for which he had his tenotomy performed having returned, he had a second tenotomy in November; he was then fitted with flat-foot plates. These operations and the plates gave him no relief whatever. He never met with any injury, and was never ill in his life, except for the grippe five years ago. Fluoroscope showed marked exostoses beneath tendo Achillis. He was operated upon two months ago in a manner similar to that already described. Large exostoses were removed. Pain about the tendo Achillis was relieved, but he still complains of pain on plantar surface of the heels. A report from him May 10th says that he was benefited a little for a time, but that now he is as bad as ever.

Case IV. This was the case of a man, aged twenty-eight years, a city laborer, who came to the dispensary about two years ago because of pain in the foot, referred to the instep. He had a very rigid foot, held in moderate pronation. Under ether, an ineffectual attempt was made to break up the adhesions and correct the position. After this, with exercises and a Thomas sole, he got along fairly well, and was lost sight of until three or four months ago, when he returned, with his pain now referred to the insertion of his tendo Achillis. There was tenderness to pressure at this point, and a prominent spur was evident in the fluoroscope, projecting from the

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posterior and upper surface of the os calcis. The fulness on the sides of the tendo Achillis was not very marked. There was nothing in his history which had any bearing on the causation of the trouble.

CASE V. This patient is a man, aged twenty-nine years, a sailor. For nine years he has been utterly unable to do any work on account of pain in his feet. This pain was referred to both tendo Achilles as well as to the plantar surface of the heel. There was nothing in his family or personal history which was at all suggestive. During these nine years he has tried all sorts of anti-rheumatic treatment, has been at various baths in this country and abroad, but is still unable to get about without great difficulty and pain. Uses canes; walking in the bare feet was impossible. On physical examination there were very marked thickenings on either side of the tendo Achillis, filling up the normal fossæ at these points; tender to pressure; hard and not fluctuating. No x-ray photograph was taken. There are also some thickenings at the metacarpo-phalangeal joints, particularly in the thumb, and he uses the hands awkwardly, as patients do with these painful joints, though in his case these are not painful, though they had been. Through incisions similar to the one employed in the last case the bony thickenings were chiselled off, together with the bursa, which was also thickened. At the end of two weeks he was discharged, being able to walk in his bare feet the first time he tried. For some time this improvement continued; but, like the previous case, he has had several setbacks which have not responded as readily to treatment as in the case of the preceding patient. His pain, however, has left the region of the insertion of the tendo Achillis, and is now confined to the plantar surface of the heel. In spite of these setbacks, he regards his condition as much better than before. Now, on physical examination, there is still considerable thickening at the seat of operation—more than should come, it seems to me, following a first-intention wound, as all these have been.

CASE VI. M. E. S., aged thirty-three years, a lawyer. Five years ago he had an attack of rheumatism in the left knee which lasted three or four weeks. After that he had no trouble until the fall of 1896. He got his feet and lower part of his body wet in a

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heavy rain-storm, and the next day both feet were sore. Five days later he refereed a foot-ball game in low shoes, and was exposed for several hours in deep mud and slush. That evening his feet were very sore. Ever since they have troubled him a great deal, being fairly comfortable for a few days, and then bad again. Always much worse stormy days.

FIG. 1.

Case VI. Shows bony spurs on upper and lower surfaces of the os calcis.

The right foot is swollen behind the heel; pain and tenderness. Motion in all directions painful, especially on flexion. Walking without shoes almost impossible. In the left foot there is no swelling behind the heel, and the pain is on plantar surface of the heel. The left foot is pronated. His treatment consisted in being confined to his bed, the application of dry heat, and bandages.

The necessity for his going to bed was brought on by his getting his feet very wet.

The x-ray photographs (Figs. 1 and 2) show the bony growth behind the tendo Achillis and also in its plantar surface.

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CASE VII. This patient (H. F. F.), a man, aged about twenty years, came to the Carney Hospital in November, 1895, on account of painful feet. He had not walked for over a year. Fig. 2 shows the bony outgrowths beneath the tendo Achillis before operation, which were removed in the spring of 1897, with a very satisfactory

FIG. 2.

Case VII. H. F. F. before operation, showing bony thickening on the upper surface of os calcis, which was removed.

immediate result. His symptoms recurred, however, in a short time, and Fig. 3 shows his condition one year after the exostoses shown in Fig. 2 had been chiselled away, showing that there has been a recurrence of the bony outgrowth. He has been very much benefited by the use of dry heat at high temperatures.

CASE VIII. This patient (B. M.) was twenty-seven years of age. Family history of phthisis; mother died of it. He had pain, swelling, and tenderness, with local heat and redness over the sheath of the tendon. This has turned out to be a case of tuberculosis of the calcaneal bursa and of the os calcis.

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In addition to these cases of which I have details, I have seen three other cases which presented precisely similar clinical symptoms and physical signs.

FIG. 8.

Case VII. H. F. F. one year after operation, showing prominent spur on plantar surface of os calcis.

In this series of cases it is possible to eliminate from the etiology influenza, scarlet fever, syphilis, gonorrhœa, acute rheumatism, fibromata, neuromata, and acute suppurative processes. Trauma does not seem to have played any prominent part, unless it be in the third case, that of the bicycle rider. If the trauma of the shoe were an important causative factor there would be more cases of this trouble.

I cannot rule out the uric-acid diathesis mentioned by some observers, because I did not test the urine. In the eighth case tuberculosis, primary either in the os calcis, which is probable, or in the bursal sac or the sheath of the tendon, accounts for one of the eight. Of the other seven, one, the fifth, presents arthritic changes in other joints, which suggest an osteo-arthritic process;

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three give no history of any probable cause, and the other three give a history of being exposed to cold, wet, and sudden changes of temperature. In the x-ray photographs the osteophytes show very clearly in Cases VI. and VII. Cases I., III., and IV. revealed the same condition through the fluoroscope, and Case VIII., the tuberculous case, did not show any definite osseous changes. The only case not examined by the x-ray before operation—viz., Case II.—did not show any osteophytes five months after operation; this is also the only case which can be considered well which has been operated upon. Case VII. has photographs before operation and one year later also. The last picture shows that there was a recurrence of the bony growth. In both the sixth and seventh cases the osteophytes appear on the plantar surface of the os calcis as well as beneath the tendo Achillis.

We have, then, a condition to deal with which is not sufficiently accounted for by traumatic influences alone; which is not dependent upon any of the acute infective processes, certainly not in this series; which runs an essentially chronic course, none of the cases being of less than two years' standing; which presents the histological characteristics of a subacute or chronic osseous inflammation, and, lastly, which does not respond to the treatment which we should expect to give permanent relief to a simple exostosis, the only case operated upon which has remained relieved being Case II., in which case the duration of the disease before operation had been nine years. All the other cases have been immediately relieved, only to be as bad as before within six months or less. Such characteristics must indicate, of course, an inflammatory process of some sort, dependent probably upon a constitutional diathesis. From the clinical stand-point, osteo-arthritis would seem to fit the condition better than any other. Unfortunately, we do not get the opportunity to study histologically the joints of osteo-arthritic patients while they are in the acute stage, and in the late chronic stage, after acute symptoms have subsided, the lesions presented are not distinctive of any special disease. However, as has been pointed out by Dr. William Adams and others, the osteo-arthritic lesions are manifested in the course of tendons, in bursal sacs, in the cartilage over joint surfaces, and in the fringes of synovial membrane within the large joints, especially the knee, shoulder, and elbow.

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He also calls attention to the fact that trauma and exposure to cold and wet are prominent factors in the etiology of that disease, and cites the unusual prevalence of osteo-arthritis in the north of Ireland, where all three of these factors are present.

In conclusion, then, though an absolutely clear case cannot be established for the osteo-arthritic hypothesis as to the cause of these osteophytes about the os calcis and metatarsus, still it would seem to afford a better explanation than can be given on any other theory.

The question of treatment, in the light of the cases here cited, must be decided on the theory that this is an osteo-arthritic process. It is well recognized that surgical interference in that disease during its acute or subacute stage is contraindicated, and such interference must be deferred until the quiescent stage is reached. The treatment in the acute stage must consist of rest, the application of dry heat and fixation bandages.

I wish to thank Dr. Goldthwait for the use of two cases in the above series, and for suggestions as to the etiology and treatment.

CONCLUSIONS: Exostoses beneath the post-calcaneal bursa are most commonly manifestations of an osteo-arthritic process. The exciting causes of this are exposure to cold and wet and trauma. The treatment should be operative only after the acute stage has subsided. The condition is one to be carefully looked for where persistent pain in the foot is present not yielding to the ordinary treatment.

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THE OPERATIVE CORRECTION OF WEBBED FINGERS.

By GWILYM G. DAVIS, M.D.,
PHILADELPHIA.

One of the oldest and simplest ways of remedying webbed fingers is that of Rudtorffer. He passed a lead wire through the proximal end of the web and kept it there until the edges of the hole had cicatrized; the remainder of the web was then divided. This method has fallen into disuse. It takes a long time to establish the opening, is distressing to the patient, and is apt to fail and be unsatisfactory from the amount of cicatricial tissue it causes.

Another operation is that of Zeller.[1] He dissected a triangular flap from the proximal end of the web on the dorsal side and slit the remaining portion. The triangular flap was then brought forward between the fingers and its apex sutured to the palm, and the raw surfaces on the sides of the fingers sutured as nearly shut as possible. Norton[2] modifies Zeller's procedure by making two small flaps, one from the dorsal and another from the palmar surface.

Dieffenbach,[3] in 1845, introduced square flaps. He raised a square flap from the dorsal aspect of the hand and sewed its end to the palmar surface. The remainder of the web was divided by a simple incision. Adhesive plaster was used to bring the wounds of the fingers together, and charpie laid in between them. He stated that he was very successful with this method.

Diday, about the year 1848 or 1849, made two square lateral flaps, one on each side of the web, extending its whole length. One flap was then wound around the finger to which it was attached, and the other likewise around the opposite one. This operation apparently is the most popular one at present.

Fowler,[4] for certain special cases with extensive cicatrices,[2] sug-

[1] Uber die ersten Erscheinungen vener. localkrank. Wien, 1810, p. 109. Quoted by Treves.
[2] British Medical Journal, 1891, vol. ii. p. 931.
[3] Die Operative Chirurgie, p. 744.
[4] Dennis' System of Surgery, vol. ii. p. 186.

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gests taking two long, slender flaps from the dorsum of the hand and bringing them forward, through buttonholes in the skin, and suturing them in the divided web.

The choice of operation depends on the character of the web to be operated on. Rudtorffer's operation with the lead wire is not desirable under any circumstances. The operation of Zeller is shown in Fig. 1, between the ring- and middle-fingers. Its main object is to secure a separation of the fingers by healthy skin and the avoidance of cicatricial tissue at that point. If this is done re-forming of the web is prevented, even though suppuration of the remaining portion of the wounds on the fingers occurs. It is a good operation

FIG. 1.

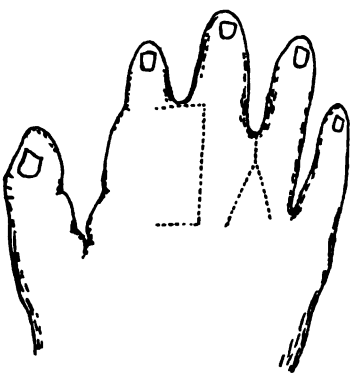
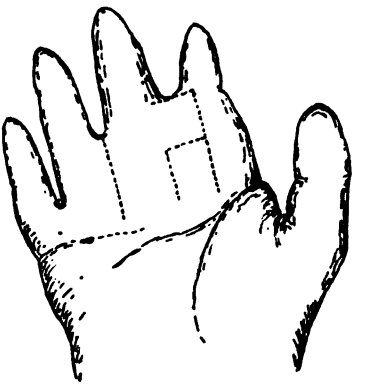


FIG. 2.



when used where the fingers are not too closely bound together and when the web is thin. I do not see that there is much to be gained by using two flaps, as does Norton, instead of one. The operation of Diday seems to be the one most extensively used. It is figured in all our text-books and recommended by most of our leading authorities. Why it should be so popular is difficult to see. Its main advantage is that the cicatrix on one finger lies more toward the dorsal aspect, while on the other finger it is more toward the palmar. Therefore, the raw surface on one finger is not opposed to a raw surface on the other. Its bad features are many. Bardeleben[1] says it is liable to fail through suppuration and sloughing. Treves[2] says:

[1] Lehrbuch der Chirurgie und Operations., vol. iv. p. 718.
[2] Operative Surgery, vol. ii. p. 131.

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"The procedure is difficult and requires infinite care in its performance. The most probable fault will be the fashioning of flaps, which prove, when adjusted, to be too narrow toward the proximal extremity." Its most objectionable feature is that there is no healthy skin placed in the web, therefore a cicatrix forms at this point which, if it heals, tends to cause a binding together of the fingers, while if accurate approximation of the flaps is not secured a raw surface is left not only at the web but also on the adjacent sides of the fingers, and these are apt to grow together in one cicatricial mass, which again binds the fingers together. Zeller and Dieffenbach struck the true keynote of success when they insisted on the separation of the fingers at the web by a strip of healthy skin, and, to my mind, no operation is desirable unless it possesses this feature.

In the hand illustrated in Figs. 1 and 2 the web between the ring- and middle-fingers was neither so long nor so thick as that between the index- and middle-fingers, and on it I did the operation of Zeller with perfect success; the apex of the flap was turned over and sutured to the end of the incision in the palm. The raw surfaces on each finger were then united by silk sutures, and primary union was obtained. The web between the index- and ring-fingers was long and thick. A square flap extending the whole length of the web, with its base on the index-finger, was then cut on its dorsal surface. On the palmar surface there was first cut a small square flap with its base toward the palm. Immediately above this, and extending from its top to the distal end of the web, was cut another square flap, with its base on the middle-finger. These flaps are shown in Fig. 2. The square palmar flap was turned in between the fingers and sutured to the healthy skin on the dorsum. The long dorsal flap on the index-finger was wound around it, covering in the raw surface, and sutured to the healthy skin in front. The upper square flap on the middle-finger was next wrapped around it and covered up the distal half of the raw surface on the middle-finger. The raw surface on the proximal half of the middle-finger was left to granulate. Union of the sutured flaps occurred, and after a short time the granulated surface had healed over, the procedure being perfectly successful. In order to obtain rapid healing without granulating surfaces, one must approximate the flaps without too much tension. To facilitate this the flaps should only be of a thickness sufficient to insure their

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vitality; any fatty tissue that is unnecessary for this object should be removed. Also the fatty tissue of the raw surfaces to be covered by the flaps should be cut away to some extent for the same purpose, as well as some of the tissue at the web. By operating in this manner one is enabled to cover one finger entirely, the web and half of the opposite finger. The only raw surface left to granulate has healthy skin below as well as above it, and also on the other finger directly opposite, so there is no possibility of it becoming anywhere adherent. The objectionable cicatrix at the proximal end of the web, which occurs in Diday's operation, is avoided, and success is more assured.

DISCUSSION.

DR. GIBNEY said that he had had very little experience with web fingers. The most satisfactory operation had been one in which an incision was made along the dorsum and along the palmar aspect of the adjoining finger, and flaps were brought around and united. He could recommend this operation very highly.

DR. GOLDTHWAIT said that there was no need of leaving a raw surface. His plan had been to get skin-flap enough from one place or another to thoroughly cover in one finger, and then to cover the rest of the raw surface with Thiersch grafts. This avoided entirely the disagreeable cicatrix which would otherwise form.

DR. H. L. TAYLOR said that at the Hospital for Ruptured and Crippled there had been recently a case of club-foot in which three of the fingers of one hand were thoroughly matted together. The case was referred to Dr. Dawbarn, who operated without making any flaps, using Thiersch grafts, and the result was exceedingly good.

DR. DAVIS said that he was sorry that Dr. Gibney preferred the operation of Diday, for that had a tendency to leave a cicatrix in the middle. Of course, an ideal operation was one in which there was no raw surface, but in an infant's finger the granulating area left on the side of one finger was so small that it quickly healed and did not leave any objectionable cicatrix.

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ADENOIDS AS AN ETIOLOGICAL FACTOR IN ORTHOPEDIC DEFORMITIES.

By F. S. COOLIDGE, M.D.,
CHICAGO.

It has so happened that quite a number of cases of beginning deformities have recently presented themselves to the writer in which it was at once evident that adenoid vegetations either were present, or else, although outgrown, had left behind them the mouth-breathing habit and the usual facial deformity of mouth-breathers. None of the cases were of simple, definite type, with fixed and well-known causes, as deformity following cerebral or spinal paralysis, or as congenital club-foot, but all were of the complex type often roughly referred to as "possibly from some nerve irritation."

A hasty description of a half-dozen cases will help in the discussion:

Case I. Lawrence S., eight years old, is now a mouth-breather, and has the typical expression. A year ago his mother noticed that he held is right foot in a peculiar position in walking. This grew worse in spite of flat-foot plates applied by a Boston orthopedic surgeon. Examination now discloses a marked non-deforming club-foot on both sides, but worse on the right. He is decidedly clumsy in all his acts, and has had frequent falls and minor accidents. At my request Dr. Dickerman made a posterior nasal examination. He found no adenoids present, but the confirmed mouth-breathing, the facial expression, the history of constant head-colds and ear-trouble, left no doubt in his mind that they had been present but were outgrown.

Case II. Frank W., ten years old; nervous temperament; frequent colds and catarrhs; mouth-breather. Eight months previous his mother noticed a droop of one shoulder, which was increasing.

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Examination showed a well-marked left dorsal lateral curvature, with rotation present, shown by the bulging backward of the angles of the left ribs. In this case Dr. Hardie had already discovered large adenoid growths, which he later removed in the presence of the writer.

CASE III. Alice W., extremely nervous temperament; absolute mouth-breathing with great facial changes, including a protruding lower lip, ptosis of left eyelid, and almost imbecile expression, although she was exceptionally bright at school. The orthopedic lesions are peculiar. The right middle-finger is contracted to 60° and cannot be straightened by moderate force, even when the girl is under ether. The corresponding left finger is also slightly contracted. Both feet are flat, and in the right motion is much limited, although no joint disease is present. She walks with steps only eight inches in length, although there is no limitation to passive motion in the hip- or knee-joints. In this case large adenoids were present and were removed by Dr. Dickerman.

CASE IV. Mary F., a nervous child, aged five years, referred to the writer for persistent in-toeing. No bony deformity was present. Mouth-breathing, with its facial expression, suggested adenoids, which were found and removed by Dr. Dickerman.

CASE V. A. S., a large, stout boy, eleven years of age, with left dorso-lumbar lateral curvature and rotation. Typical effects of previous mouth-breathing were noticed in his expression, in the high narrow vault of the mouth with jaws several sizes apart, and a lisp in the speech; but from the quiet nasal inspiration the writer concluded that the adenoids were outgrown. Later the mother wrote that he was again snoring at night and troubled with catarrh, and last week a more careful examination disclosed extensive adenoids, which will shortly be removed.

Two cases of non-deforming club-foot in adults, existing since youth, in which the facial expression of each bears testimony to previous mouth-breathing, might be mentioned as having been observed by the writer. Also one case reported to him by Dr. Dickerman, in which he noticed marked in-toe in a boy, nine years old, upon whom he was operating for adenoids.

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Granted that adenoids might have some connection with orthopedic deformities, what could that connection be?

1. Both the adenoids and the deformity might be an expression of degeneracy and have no closer connection than lies in that. But laryngologists, as a rule, agree that only very few adenoids are congenital, and the class of deformities with which this paper deals is certainly not of congenital origin. Furthermore, there is as yet no evidence of the frequency of adenoids in cases of malformations or degeneracy. The latter subject is, however, being carefully investigated in Germany at present, and more light will soon be thrown upon the matter.

2. Deformities might occur as a direct result of the mechanical obstruction to breathing. This is no hypothesis, for it is well known that deformity of the chest, as pigeon-breast, results not infrequently from adenoids. Many laryngologists speak of it. Harrison Allen gives a minute description of it, and Redard has written upon this subject from an orthopedic stand-point, and it need not detain us here.

3. Orthopedic deformities occur in tubercular joint diseases which may have had their source of infection either directly or indirectly from adenoid vegetations. Though this theory has never been advanced, to the writer's knowledge, it certainly cannot be regarded as improbable. The further investigation is carried the more frequently is it found that adenoids are of a tubercular character. It is questionable whether in such cases the growths are tubercular from the start or whether tuberculosis has been grafted upon them later, but still they are tubercular. Fisk found five out of thirty-two to be tuberculous; Goetschen found four out of thirty-three; Brindel found eight out of sixty-four.

This local tuberculosis might surely be the source of the direct infection of any joint or tissue in the body. More frequently, however, the infection is indirect. Adenoids are unquestionably a frequent cause of tubercular glands of the neck, by causing first a mild adenitis, which in children is so likely to develop later into tubercular adenitis, and dissemination from tubercular cervical glands is a well recognized cause of joint disease.

In yet another way do adenoids act as an indirect etiological factor in joint disease. By lowering the general condition they

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lessen the normal resistance to and favor the growth of tubercular infection anywhere that the germs may lodge.

4. Deformity may result directly from the reflex irritation of neighboring nerves by the adenoid growths. This is not a new theory, for Gillette has described before this Society two cases of wry-neck due directly to adenoids. The writer recalls a similar case seen seven years ago in Ridlon's clinic in New York.

5. Last and most important, however, and a theory that the writer cannot find mentioned in connection with orthopedic surgery, at least, is this: That adenoids may cause such a lowering of the general nervous vitality that they may be considered almost the direct cause of some of the atypical orthopedic deformities whose etiology is unknown, but is indefinitely referred to the nervous system.

Harrison Allen says: "The general state of the patient is affected in many ways by the presence of the growths. The imperfect rest and unnatural breathing create anæmia, which, occurring in the system when the growth-forces are actively engaged, produces a variety of disturbances, chiefly in the direction of functional disorders of the thoracic and abdominal viscera and of the nervous system."

L. Browne lists the results of adenoids as follows: (*a*) Chest deformities, not infrequently; (*b*) hernia from straining to clear the nose; (*c*) stupidity, megrim, etc., and melancholia; (*d*) reflex neuroses, including asthma, epilepsy, chorea, convulsions, stuttering, aphonia, and whooping-cough.

The bridge from such nervous manifestations as these to the nervous manifestations expressed by such deformities as are described in this paper must be a short one.

Furthermore, these same deformities, with the exception of the lateral curvatures, are distinctly double-sided, although one side may be more affected than the other, and perhaps even lateral curvature might be classed more rightly as a bilateral than a unilateral affection. And as they are bilateral, we must look rather for some general cause than any purely local reason. Might not the nervous depression following adenoids well be one of those general causes? The focussing of the nervous depression to a manifestation in this or that particular locality would be due to the accidental local conditions existing there.

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While the writer advances these thoughts and theories with some hesitation, knowing that as yet it must be only a matter of speculation, yet he is convinced that Luschka's tonsil plays a more important part in our specialty than has been generally realized.

DISCUSSION.

DR. GOLDTHWAIT thought it would be interesting in this connection to mention the work done by Dr. Goodale, of Boston, as to the power of the tonsils and adenoids to absorb poisons of all sorts. He claims that this is one of the chief sources of infection of the cervical glands. He treats the cervical glands by applications to the tonsils, and with some very striking results.

DR. GIBNEY said he desired to compliment the reader of the paper on his presentation of this subject. All of us were grasping after some of the causes of deformity, and it seemed to him just as much orthopedic to remove an adenoid because of a deformity as it was to remove the deformity itself.

DR. KETCH asked Dr. Coolidge if any direct results were obtained by the removal of the adenoids. It was easy to understand how adenoids might be a source of infection for the tubercular joint diseases, but he could not readily understand the relation, for instance, between a rotary lateral curvature and adenoids. He could understand how, by interference with the respiratory function, a non-rotary lateral curvature might result, but he could not understand how a rotary lateral curvature might be caused in this way.

DR. H. L. TAYLOR said he had not heard Dr. Coolidge speak of the relation of absorption of toxins by the throat to acute torticollis —that form of torticollis which comes on suddenly with a good deal of pain and stiffness, and where there is evidently a deep infection of the muscles of the neck. When properly treated this form usually passes off in a few weeks. In these children it seemed to him there had been an absorption of infectious material through the

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throat, whether through the tonsils or adenoid tissue of the pharynx, he was not sure. It was at least interesting to inquire whether such cases were not more likely to develop in children with adenoid growths.

DR. SHAFFER said that he had recently seen a case of epilepsy in the practice of Dr. Urban G. Hitchcock, in which the adenoids had been removed. The epileptic seizures had existed for three or four years, and there would be eight or ten attacks of *petit mal* every day. After the removal of the adenoids the epileptic seizures ceased for a time, but returned. After a second operation they again disappeared for a considerable time, only to return after the boy had received a blow on the head. From this case, and one or two others having a somewhat similar bearing, he had been led to believe that the adenoid growths, through the nervous system, might produce important results in remote parts of the body.

DR. COOLIDGE closed the discussion. He said that he had not taken up at all the results of treatment, having dealt entirely with the etiology. His own feeling was that simple removal of adenoids would have no effect on deformity at once, although the removal of this tissue was an important step in the general treatment. His paper was offered chiefly from the stand-point of prophylaxis. Absorption might come from the tonsils themselves without the presence of the third tonsil.

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GROWTH IN SPONDYLITICS.

By HENRY LING TAYLOR, M.D.,
NEW YORK.

One of the most striking and serious results of Pott's disease is the dwarfing which it produces. A direct reduction in stature is caused at any age by loss of vertebral substances and spinal deformity, while in the young growth is retarded by the state of malnutrition incident to the disease. The amount of dwarfing will, therefore, depend in a given individual on the age of invasion and the location, amount, severity, and duration of the morbid process, as well as upon the hygienic and surgical management of the case. The ultimate result, in all but a few exceptionally favorable cases, is a stature (and weight) considerably below normal. All the foregoing statements have been verified by measurements of private patients, taken from time to time, and while the number of observations is too small to establish growth-curves for spondylitis under varying conditions, the results seem to be of sufficient interest to warrant a preliminary discussion of the topic, especially as the measurements in a number of cases have extended over a series of years, giving fairly complete individual records.

In general it may be said that the severe, early cases suffer most, and especially those where early, strict protective treatment is omitted. The growth-curves of patients treated early show more progress than those of patients whose treatment was delayed. Strictness and laxity of treatment are also plainly registered in the curves.

Disease of the cervical region is least harmful in this regard; disease of the dorsal, especially the lower half, the most so, while disease of the lumbar region occupies an intermediate position. An average growth of an inch to an inch and a half extending over a number of years, instead of the normal two inches and upward, is fairly satis-

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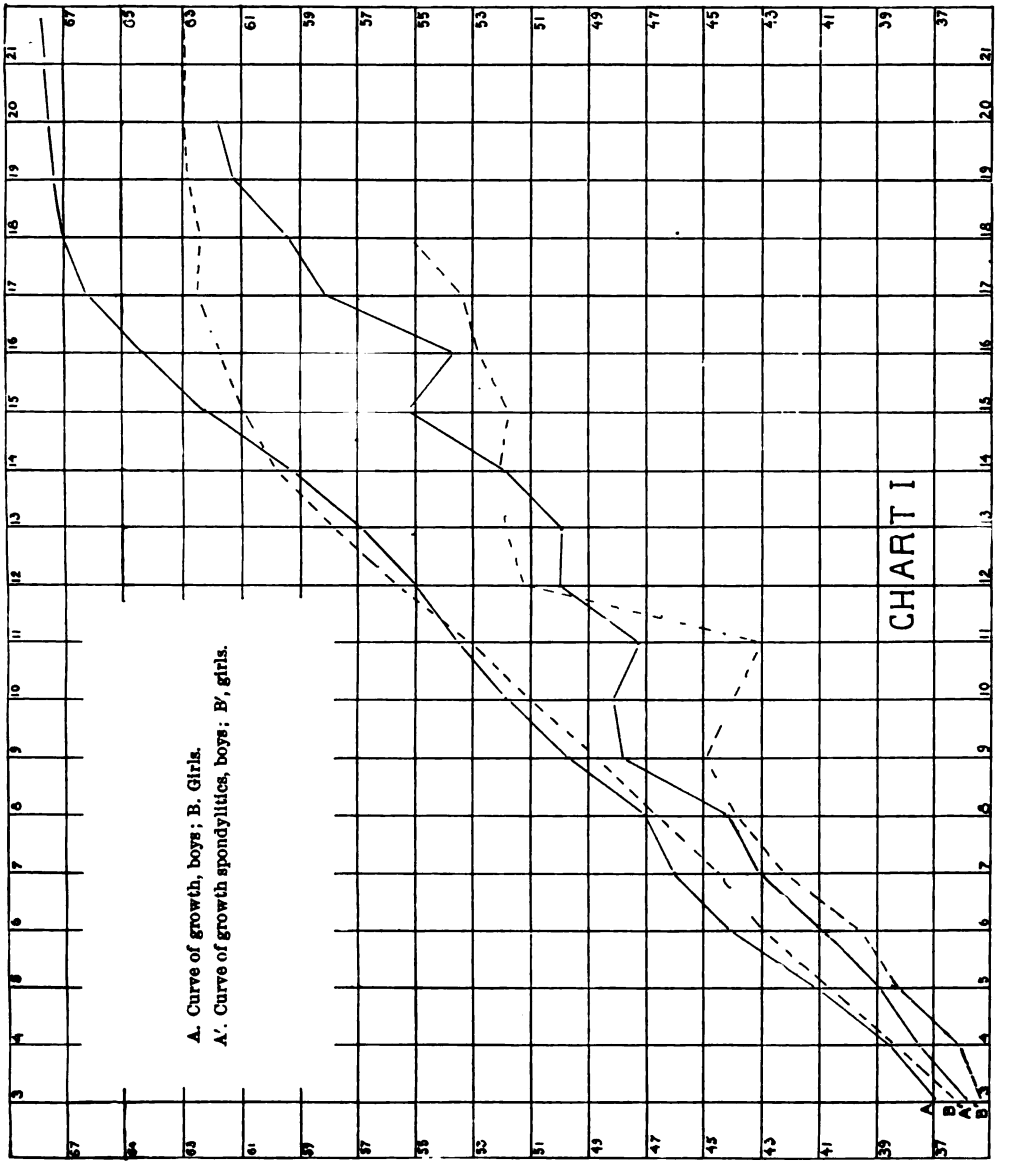
factory for patients under treatment during or soon after the active stage of the disease. A growth of one and one-half to two inches for a similar period indicates that disease is arrested or is retrogres-



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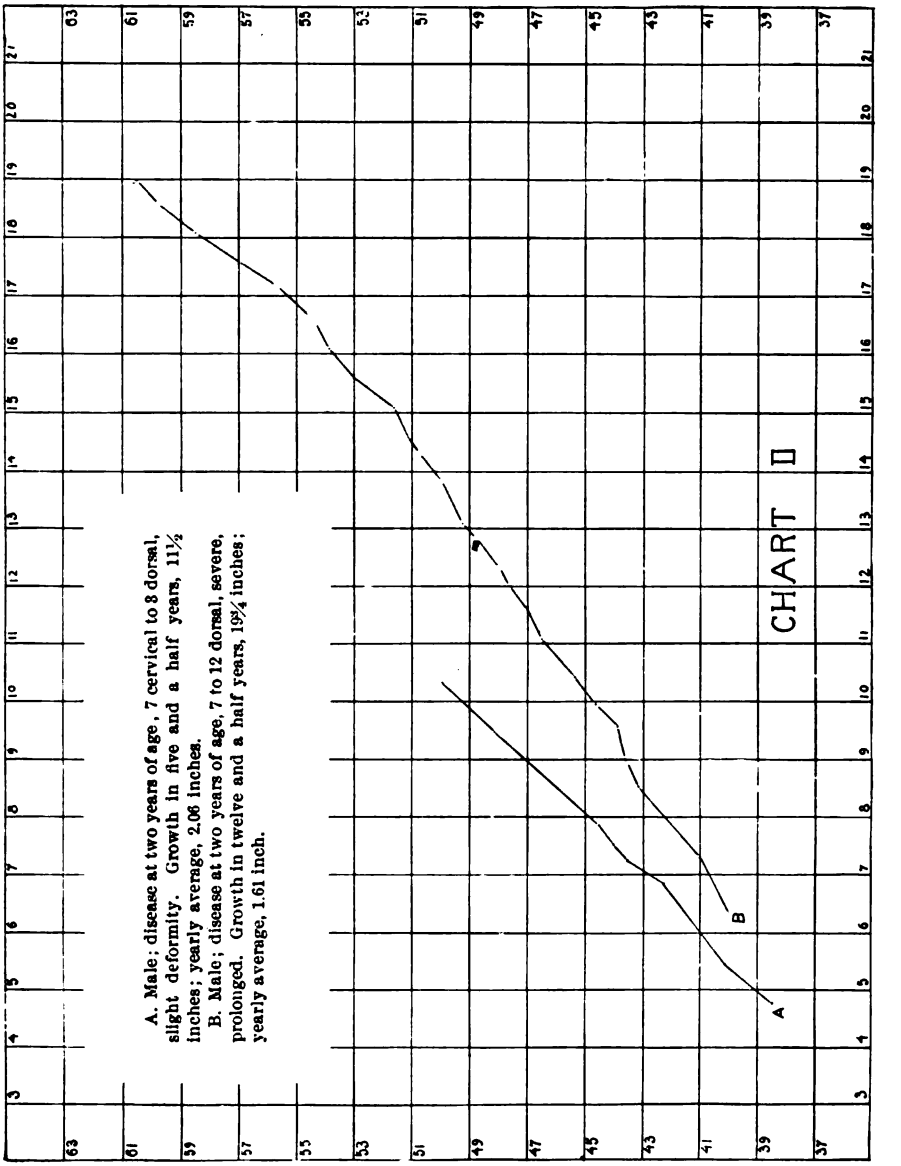
sive, in other words, that the case is doing well. Very slow or absent growth indicates progressive disease or impaired vitality. Intercurrent disease or too long absence from surgical supervision is



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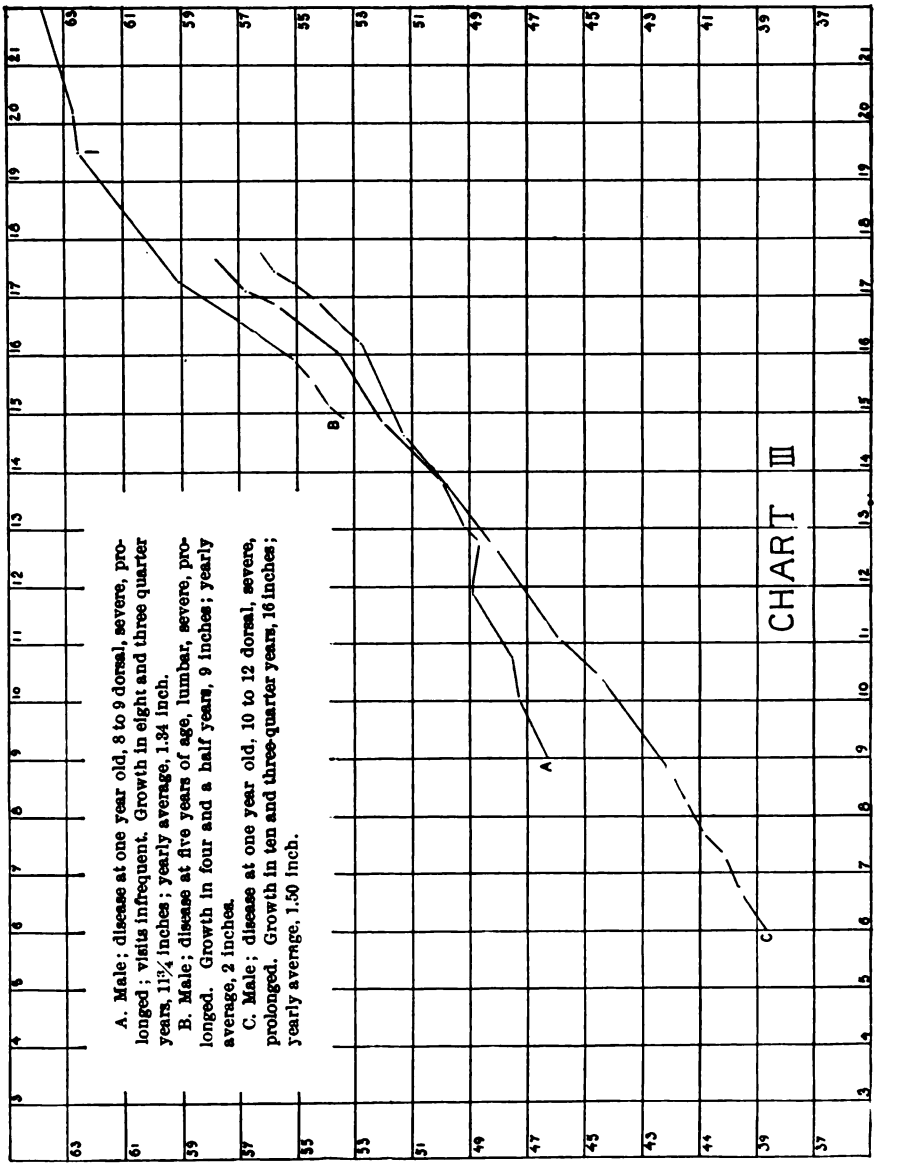
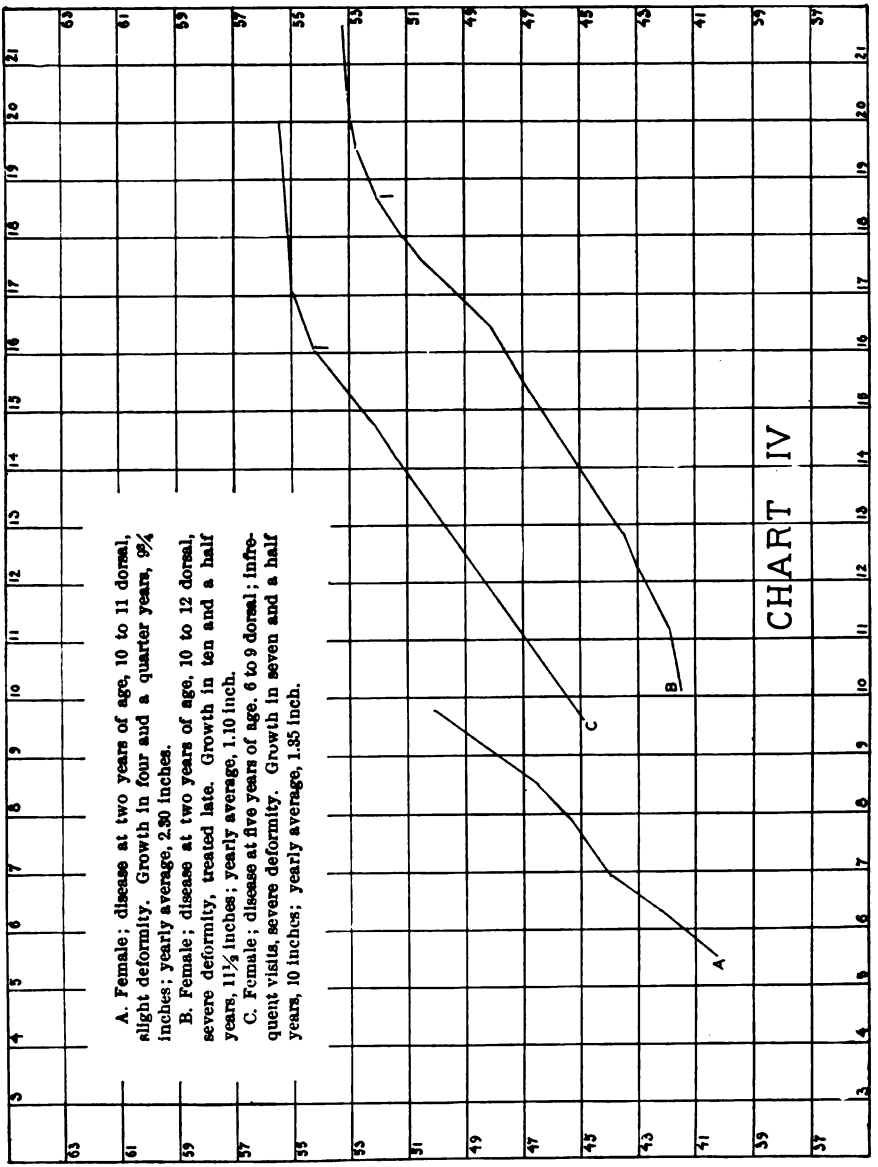
often followed by a diminution in the growth-rate; but pulmonary phthisis in a delicate lad now under observation does not appear to have interfered with his growth. It has seemed to me that under



unfavorable conditions girls suffered more than boys—that is, the resulting dwarfing was more extreme.

Although, as stated, the number of observations is too small to



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plot a definitive curve of growth for spondylitis, the provisional curve preserves in a general way the relations of the curves of average growth, as shown on Chart I., where the spondylitic curves for girls and boys are compared with curves plotted from Robert's measurements of English school children. A comparison shows that the spondylitics are far below the average height for age, that the girls are below the boys, except between twelve and fourteen years, when their line crosses that of the boys as in normal children.

The curves of a number of individual spondylitics (Charts II., III., and IV.) show, even more clearly than the curve of averages, that the period of prepubertal acceleration is delayed to the sixteenth or seventeenth year, as might be expected from the postponement of puberty itself. Cases that have recovered or are recovering, even if severely deformed, experience a marked acceleration of growth during the seventeenth, eighteenth, and nineteenth years. Childhood is, in fact, prolonged in these cases, and we find, in addition to the postponement and accentuation of the prepubertal acceleration, a prolongation of the period of growth for several years; appreciable gains are even possible in the twenties.

Measurements of the standing height and sitting height previous to, during, and after the adjustment of supporting appliances, will afford definite information as to the efficiency of the manipulations, and give much aid in keeping the support at a high standard. Measurements of height also afford valuable information on a point where information is much needed, namely, in connection with the discontinuance of mechanical support, often a difficult point to decide. Apparatus should not be removed during the growing age unless the patient has exhibited a fair rate of growth for at least a year or two preceding. Moreover, after the apparatus has been removed, if measurements show a decided retardation of growth, it should be reapplied. In this connection it should be remembered that even after long quiescence or definite arrest of the disease, the removal of supporting apparatus is often followed by increase of deformity due to static conditions. The observed facts justify and even compel in many cases retention of support long after all acute or focal symptoms have subsided.

It is hardly necessary to say that the measurements should be taken after the removal of the shoes, and at about the same time

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of day, also, in all cases under treatment, with the apparatus applied.

The retardation of growth is probably felt in all parts of the body, though a series of measurements to determine the relative effects in the trunk, head, and limbs would be interesting. The direct effect of the deformity is exhibited in the trunk alone. The limbs are, therefore, relatively much longer than the body, and the latter is proportionately more curtailed than even the measurements of stature would indicate. For this reason it would seem very desirable to take the sitting height, and perhaps the measurements from the iliac spines to the malleoli in addition to the standing height. The weight taken at stated intervals also affords valuable information.

In so far as one can measure and weigh results, art is reduced to science. Lead tape tracings of the spinal contour noted from time to time give, perhaps, the most exact and valuable knowledge obtainable of a patient's progress during a series of years, and are simply indispensable for recording the results of treatment. If such tracings are supplemented by systematic records (say two or four times a year) of the standing heights and sitting heights, and the weight of each patient, our data will be superior to that which we possess for most diseases, and would not only give valuable information with regard to the progress of each case, but would soon enable us to judge with scientific exactness of differing methods of treatment.

DISCUSSION.

DR. KETCH said that it had been long known that the retardation of growth was one of the necessary results of Pott's disease, but the paper had placed the facts in a form convenient for reference.

DR. SAYRE indorsed what had been said by the last speaker, and expressed the hope that after a number of years, during which sufficient data could be accumulated, important deductions might be made.

DR. JUDSON said that the first questions asked usually are: What is the cause of the disease, and what effect will it have upon the

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stature? The contribution would tend to make our knowledge on this subject more exact.

DR. TAYLOR said that the paper was merely a preliminary report. He called special attention to the fact that the acceleration of growth might be looked for very much later than in other children. The special object of the paper was to emphasize the importance of taking regular and systematic measurements—a practice which he believed was not very general.

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VOLUNTARY LATERAL DISLOCATION OF THE KNEES IN INFANTS WITH LAX LIGAMENTS. TWO CASES.

By AUGUSTUS THORNDIKE, M.D.,
BOSTON.

This condition has been noted by the writer twice. Both times the parents came for medical advice on account of a snapping noise in the knee. The displacement was not noticed by them, although very conspicuous.

Annie H., of Somerville, brought to the West End Infant Hospital, Out-patient Department, November 24, 1893, aged eight months. Mother says "the knees snap," also, "for two months she has noticed a grating noise in the knees." The left knee admits of slight lateral motion, both in abduction and in lateral sliding. This is much more marked if the knee is partly bent, and can be done voluntarily, producing a noise and deformity which can also be reduced at will. When it has snapped out the internal condyle is very prominent and the shin is not in line with the centre of the thigh. The right knee admits of the same displacement, but to a slightly less amount. She was said to snap this knee herself, and the dislocation could readily be produced by my hands and as readily reduced. Light iron splints with double uprights and a simple joint were applied, and six months later the knees allowed of only a very little lateral motion.

I saw her again last month, four and a half years after the first visit. She is well and strong, and the motion of the knee-joints is normal.

James C., aged thirteen months. Brought to the West End Infant Hospital, Out-patient Department, March 12, 1898. Mother says she is "not sure that there is anything the matter with his

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knee, but he keeps cracking it." James began to walk at eight months, and walks well for his age. He is well developed, but thin, especially in the legs; he has the square head of rickets, enlarged epiphyses at wrists and ankles; also a well-marked rosary.

Right knee: when he flexes to about fifteen degrees there is a sudden jar and snap, and on examination we find the outer condyle of the femur resting on top of the inner tuberosity of the tibia. No hyperextension is allowed, but there are free lateral motion and rotation in the straight position.

Left knee admits of similar abnormal movements, and can be dislocated laterally; but the child has not been seen to do it unaided.

As his parents were unable to pay for apparatus, plaster bandages were applied.

One month later the note is as follows: "Considerable lateral mobility in both knees, but less than before; did not snap his knee voluntarily. New plaster bandages applied."

In considering the mechanics of this dislocation, two factors seem to exert a strong influence upon its production—possibly others—the popliteal muscle and the crucial ligaments. The popliteus muscle pulls from its origin on the external condyle of the femur to its insertion on the posterior surface of the tibia just below the internal semilunar cartilage. In the straight knee it pulls the tibia up and out; in flexion it pulls more out and less up.

The crucial ligaments are probably relics of the divided knee-joint found in some mammals, and represent the external and internal lateral ligaments of the inner and outer joints (Quain). Their function is to hold the joint surfaces in apposition; in doing this they supplement each other, the anterior ligament is tight in extension, the posterior in extreme flexion, while in partial flexion all the ligaments of the knee are relaxed, and rotation of the tibia is allowed (Gray) It is in this position that the popliteus muscle exerts a pull upon the tibia outward, which, with the ligaments of normal length acting as a fulcrum, is converted into inward rotation of the tibia. If the restraint of normal ligaments be wanting, dislocation of the tibia outward occurs. Conversely, if the tibia be displaced outward, the luxation will be reduced by the tightening of the ligaments either in extension or in flexion—in extension by the tightening of the

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lateral ligaments and the anterior crucial ligaments, in flexion by the tightening of the posterior crucial. This dislocation is due primarily to an abnormal length of the crucial and lateral ligaments of the knee.

Orthopedic treatment for little children should consist in protecting the knee by a simple appliance against abnormal movements and stretching of the weak ligaments. Flexion and extension should be allowed within normal limits, and this treatment should be persevered in for many months, perhaps for years, to give the ligaments a good chance to become strong and tight.

DISCUSSION.

DR. WHITMAN said he had seen several of these cases, usually called by the mothers "snapping knee." He had regarded it of slight importance and had treated it by a simple bandage. It appeared to be a form of subluxation, caused by muscular contraction, due apparently to laxity of the ligaments.

DR. GILLETTE said that he had seen a number of these cases in children, and had always attributed it to the rhachitic relaxation of the ligaments. Under constitutional treatment alone his cases had recovered. He thought it was a self-limited disease, and that this explained recovery under the use of the plaster cast. He had seen this also in cases of sprains that had worn a plaster cast too long.

DR. THORNDIKE said that in one of the cases he had found no evidence of rickets.

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CONGENITAL DISLOCATION OF THE SHOULDER, ITS ETIOLOGY AND PATHOLOGY, AND AN OPERATION FOR ITS RELIEF.

By A. M. PHELPS, M.D.,
NEW YORK.

REGARDING the operation, let me say that the incision should be made along the posterior border of the deltoid muscle, curving it downward. This gives a flap which readily exposes the head of the bone. The capsule is then incised. The head of the bone will be found under the spine of the scapula. It will be necessary to cut away two-thirds of the head of the bone, or down to the epiphyseal line. The bone should be rounded off like the original head, and then slipped into the glenoid cavity. The entire new articulation which has been formed by the head of the bone is next incised with a chisel or sharp spoon. The redundant capsule is then cut away and the capsule stitched with catgut. I have dressed my cases with the elbow well back, but I think it is a mistake, because none of the cases has been able to raise the arms to the perpendicular. I should therefore advise the dressing of the arm in the elevated position, so as to secure this motion, which is the only one lacking. Of course, the arm will be a little shorter than the other, but to all intents and purposes the shortening is of no account. Two of the cases have not recovered from the paralysis. In a little child operated upon the head of the bone could be distinctly felt under the spine of the scapula. Under ether the dislocation was reduced. For some reason that child cannot get the arm to the horizontal position. It is well known that in dislocations of the shoulder-joint recovery with perfect articulation is quite uncommon. These cases must not be confounded with obstetrical paralysis. Out of every ten or fifteen cases of obstetrical paralysis there will be found one case of congenital dislocation, due to violence at or before birth.

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DISCUSSION.

Dr. L. A. Weigel took exception to the statement that the majority of cases which had been heretofore regarded as paralytic are due to dislocation. If all cases of paralysis—birth palsies, so-called—were carefully examined, the larger number would be found to be palsies, pure and simple, uncomplicated by injuries of the shoulder-joint. Dr. Phelps seemed to call all cases of pathological condition about the shoulder "congenital dislocation," whether that malformation is due to injury before birth or due to injury at the time of delivery. It was perfectly possible to have a combination of paralysis with dislocation; the one, however, not dependent upon the other, as he seemed to claim. There were unquestionably cases in which the paralysis was not due to pressure of the dislocated head, but to a central trouble or to an injury occurring at birth.

Photographs were exhibited of a case in which there was a history of severe instrumental delivery with an ordinary vertex presentation. The child was asphyxiated at birth, and it was stated that the head was compressed for five hours prior to delivery. The speaker said that he had seen the case shortly after its birth, and had been struck with an absolute hemiatrophy of the face, indicating some trophic disturbance. In addition there was a paralysis of the arm. The child is not three years old. He was positive that there was, in addition to the paralysis, a pathological condition both of the shoulder and elbow, so that pronation and supination were interfered with. A radiograph was presented to show the condition of the shoulder. The child had been treated at an out-patient service by electricity as a palliative measure. This had produced a certain amount of improvement in the usefulness of the arm. Notwithstanding the abnormal condition of the shoulder, the child is able to bring the hand to the opposite side and to raise the arm a considerable distance. As Dr. Phelps, in operating, destroys a portion of the humerus, there seemed to be a risk of getting bony anchylosis or a flail-joint. For these reasons he doubted the advisability of operating in the case he had just described. The question as to whether the paralysis was primary or secondary

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seemed to him an open one. In the majority of cases he did not believe it was due to pressure of the head. With paralysis of the shoulder muscles a subluxation or true luxation may occur, just as takes place in other relaxed conditions.

Dr. Weigel then cited the case of an infant, a few days old, who was born with double club-foot, congenital dislocation of one hip, and a club-hand. In this case there was also apparently paralysis of the arm. He had made a radiograph of the child, and hoped to be able to present it before the close of the meeting. Within the last few months he had seen several other cases of paralysis in which there was the typical pronation of the hand, and in which he was absolutely sure that there was no dislocation of the shoulder, and that the case was purely paralytic.

DR. CHARLES L. SCUDDER, of Boston, said that he had seen several instances of what he considered to be a true congenital dislocation of the shoulder-joint, and in these the physical examination showed a distinct shortening of the clavicle upon the affected side and of all the bones of the upper extremity. This seemed to be an important factor in determining whether there was a congenital dislocation or simply a subluxation due to paralysis.

DR. H. L. TAYLOR said that many cases of ordinary obstetrical paralysis were observed at the Hospital for Ruptured and Crippled, and an effort had been made to find among them cases of congenital dislocation, but so far without success. In most cases the obstetrical paralysis is peripheral, not central.

DR. PHELPS, in closing, said that he had meant to say that the paralysis is entirely independent of the dislocation. Bony anchylosis would never take place if the cartilage were left on one side and the glenoid cavity were not disturbed. He would advise Dr. Weigel to put the bone back into its proper place under ether before adopting any other treatment. The chief point which he desired to emphasize was an examination of these cases to determine if the head of the bone is out of the socket; if it is it should be put back into place. In cases of paralysis the humerus would not be found shortened or

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the head of the bone out of the socket. When the latter condition obtained, it was pretty good evidence that the paralysis was the result of the same cause that produced the dislocation.

DR. SCUDDER said that it seemed to him there was a misuse of terms. There was such a thing as dislocation of the shoulder and also a misplacement of the shoulder-joint, the latter being congenital.

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CONGENITAL ABSENCE OF THE PATELLA, OR ITS TARDY DEVELOPMENT.

Summary of Fifty-one Cases, Old and New.

By AUGUSTUS THORNDIKE, M.D.,
BOSTON.

The patella first appears in the third month of fœtal life as a cartilaginous deposit in the quadriceps tendon. It is all cartilage until the child is three or four years old, and sometimes as late as the seventh year, when one (rarely two) centres of ossification form; it is completely ossified about the age of puberty. Careful palpation must be the means of determining its absence in early life, for the x-ray cannot demonstrate it until ossification begins, which may be as late as the seventh year.

In some instances it develops late in childhood; in others it fails to appear. Its absence is characterized by a broad and flattened appearance of the front of the knee; by unusual prominence of the condyles of the femur in the popliteal space, and by more or less impairment of function in the knee-joint. This impairment is sometimes slight; at other times it involves considerable disability from faulty insertion of the tendon, flexion with anchylosis or subluxation, or from hyperextension.

Several writers have lately collected and grouped together recorded cases as an aid to the study of this deformity: Phocas and Potel, in the *Revue d'Orthopédie*, September, 1896; W. B. Hopkins, in the *Annals of Surgery*, January, 1897; A. T. Bristow, in *Medical News*, January, 1897; and E. Muirhead Little, *Lancet*, September 25, 1897, have collected cases for comparison. As I have merely added a few more cases to Little's list, I have, for convenience, numbered them as he did in his tables.

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CASE I. Observed by the Swiss Surgeon, Dr. A. C. Chatelain, of Neuville, France, in 1820. A new-born infant with left genu recurvatum and absent patella. The mother had, during pregnancy, received blows on the abdomen from falls.

CASE II. A note by the editor of the *London Medical Gazette*, January 19, 1833. "There is a patient in St. George's Hospital in whom the patellæ are entirely wanting. The knee looks rather flatter than usual, but no apparent evil results from this anomalous formation, as the man says he can walk many miles a day without difficulty. The peculiarity is hereditary, neither his grandfather nor his father having had patellæ, and it also extends to other members of his family."

CASE III. Wützer (in *Müller's Archiv* for 1835) describes a six-months-old boy with congenital dislocation of both hips and abnormal mobility of the knees; both patellæ were absent, giving a flat appearance to the knees.

CASE IV. Hilton (*Lancet*, 1862, vol. ii. p. 497) gives a history of the late growth of the patellæ in a young woman, aged twenty-seven years. He had seen her from the time she was a baby of three months. At that time the knees allowed an excess of motion in all directions, laterally, in rotation, and in hyperextension. When four years old small patellæ were discovered. At puberty she walked well, and when last seen was on her feet all day without lameness or discomfort.

CASE V. Duval (*Traité Pratique du Pied Bot*, 2d edition, 1843, p. 94). Infant, aged sixteen months, with absence of both patellæ and double equinus.

CASE VI. Ammon (*Angeborne Chirurg. Krankheiten*). Infant, aged eighteen months, with absence of both patellæ; both knees are practically flail-joints and the thigh muscles extremely weak. Also had double equino-varus; fibula was absent, and there was one club-hand.

CASE VII. (Samuel Bard, quoted by Bristow, *Medical News*, January 7, 1897.) A new-born child, with one genu-recurvatum,

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was treated by a bandage and had a serviceable knee at three years. Improvement very rapid ; no displacement after one week.

CASE VIII. Brodhurst (*Nature and Treatment of Club-foot*, 1856, p. 32). Infant, aged two months, both knee-caps wanting. Genu-recurvatum held stiffly by contracted quadriceps. Left talipes varus, right valgus.

CASE IX. Dr. Moore (*Langenbeck's Archiv*, vol. xvi.). A new-born child, with a reducible anterior dislocation of the right knee. Much improved by a stiff bandage.

CASE X. Lane (*Lancet*, 1858, vol. i. p. 63). Boy, aged eight years, with double equino-varus and absence of right patella.

CASE XI. E. T. Caswell (*American Journal of the Medical Sciences*, vol. l. p. 82). A man, aged forty-three years, with both patellæ misplaced over the external condyle, the left very minute. He cannot walk down stairs nor down hill without great caution.

CASE XII. Maas (*Archiv klin. Chirurg.*, 1874, vol. xvii. p. 492). A boy, aged three years, with the right leg dislocated forward and both patellæ absent. The toes touched the abdomen, nevertheless the dislocation was easy to reduce, and the muscles in good condition. The knee could hyperextend 70° beyond the straight position, and flexion was almost normal. While wearing a simple apparatus, with a hinge at the knee stopped so as to prevent hyperextension, the child could run and walk without difficulty. There was also right genu valgum.

CASE XIII. W. Körte (*Deutsche Zeitschrift für Chirurg.*, 1876, Band vii. p. 67). Girl, aged two and a half years, unable to stand or walk ; both knees hyperextended and allow considerable lateral and rotary motion, but cannot be bent beyond the straight position, the condyles of femur bulging prominently in the popliteal space ; the internal condyle more prominent than the external. Double equino-varus and unusual mobility of the hips, allowing hyperextension till the thigh touched the back. Sensa-

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tion was normal; but the muscles, except the adductors, were weak, though stiff, and their electrical excitability was deficient. The arms and hands held stiffly flexed over the breast. Treatment, tenotomy for club-feet, and plaster bandages. Much improved after a few months.

CASE XIV. Idem. Boy, aged seven weeks, both thighs held on abdomen, and knees also strongly flexed. Double equinus. Both patellæ absent; hips allow a few degrees of motion limited by spasm; but the knees permit no motion, except that the left tibia can be rotated inward on the femur till the toes point backward. Muscles of the front of thigh flabby, the hamstrings strongly contracted; all the muscles respond readily to electricity. After five months' treatment, including tenotomy for club-feet, baths, electricity, and massage, he was discharged improved, the legs capable of active movement and flexing to an obtuse angle.

CASE XV. Jolicœur (*Bull. Soc. Chir. de Rheims*, 1873, vol. xii. p. 67). A three-year-old child, with rudimentary right and absent left patella; hyperextends the knee 45°; flexion almost normal. Considerable lateral motion allowed. Cannot walk alone; no other malformation.

CASE XVI. M. Labbe (*Bull. de la Soc. de Chir. de Paris*, 1875, p. 508). A boy, aged fifteen days, with both patellæ absent, and loose, flail-like knees allowing free rotation outward; also a "double astragalus."

CASE XVII. W. Adams (*Club-Foot*, 1873, p. 221, quoted by E. M. Little). A baby, aged six months, with club-hands and double varus; absence of left patella, and stiff knees. The right patella is rudimentary.

CASE XVIII. Idem (*loc. cit.*). A boy, aged six months, with double club-foot and absence of both patellæ, together with knock-knees and subluxation of the leg forward.

CASE XIX. R. Barwell (*Lancet*, 1877, vol. i. p. 389). A six-weeks-old boy was seen at Charing Cross Hospital by Dr.

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Barlow, and later referred to Barwell, who chloroformed, flexed both knees, and applied a plaster bandage. One month later the patella appeared, and in six weeks was nearly or quite normal. This child had kept the knees hyperextended with a deep fold over the front of each knee; the left patella was small, the right absent. The thighs for a long time could not be straightened on the pelvis, but there was remarkable flexibility in the loins, the position simulating though not due to hip-dislocation. The right foot was in equino-varus; there was also double internal strabismus.

CASE XX. Kroenlein (*Lehre von Luxationen*, quoted by Little and by Phocas). An infant, aged two days, with anchylosis of the left knee in hyperextension.

CASE XXI. Idem (*loc. cit.*). Forward displacement of both knees, dislocated hips, and absence of both patellæ, which were present six months later.

CASE XXII. Railton (*British Medical Journal*, 1892, vol. i. p. 960). A girl, aged nine months, with both patellæ absent, slight genu valgum and varus of left foot. Both the left knee and hip are so loose that the foot can be turned outward till the toes point straight back. Child has slight rickets, but is otherwise healthy.

CASE XXIII. Hartigan (*Lancet*, 1880, vol. i. p. 733). Colored baby, with the left knee flexed on the front of thigh and in contact with it, the sole of the foot lying in the groin and looking upward. Cannot be straightened beyond a straight line.

CASE XXIV. Quoted by Little (J. Guérin, *Œuvres*, liv., iv. p. 606, Paris, 1882). Boy, aged seven years, with right patella absent and left rudimentary; double varus; adherent scars over the sacrum; stiff elbows, etc.

CASE XXV. Quoted by Little and Phocas (from Heinecke, *Krankheiten des Knies*, in *Müller*, vol. xxii.). Child, aged three and a half years, with double equino-varus and absence of both patellæ.

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CASE XXVI. Dukhowski (*Proceedings of the Odessa Medical Society*, 1884, No. 11, p. 161, and *London Medical Record*, 1885, vol. xiii. p. 299). A soldier, aged twenty-two years, was discharged as unfit for military service on account of difficulty and fatigue in walking. The right patella was absent, the left the size of a small almond; knees flex so that the heels easily touch the buttocks.

CASE XXVII. Bernstein (quoted by Dukhowski). A young officer, whose gait was unsteady; one patella absent, the other rudimentary.

CASE XXVIII. C. Müller (*Arbeit. aus der Chirurg. Clinik*, Leipzig, 1888, quoted by Kermisson, *Maladies Congenitales*, 1898). Autopsy of a stillborn female infant at term. There was subluxation of the left knee; no patella; tendon of the quadriceps, which was very broad and flimsy, lost itself in the joint-capsule and the aponeurosis of the leg; traction on the muscle was without action on the leg. There was a congenital dislocation of the hip and left club-foot.

CASE XXIX. C. Müller (*loc. cit.*). Female infant, aged five weeks; the left patella absent; left genu-recurvatum and talipes equino-varus of same side.

CASE XXX. J. Stahl (*Berlin. klin. Woch.*, 1889, p. 42). New-born babe, with dislocation of right knee forward, and absent patella, which appeared at one year of age.

CASE XXXI. Pello (*Archiv. di Ortopedia*, vol. xi. p. 1, quoted by Little). Infant, aged eleven months, and deformed by arrest of development in all the limbs and multiple anchylosis. The left patella was absent.

CASE XXXII. Salaghi (*Archiv. di Ortopedia*, 1894, p. 222). A two-year-old girl, with hyperextension of both knees and left genu valgum. Both patellæ were wanting. Walks with splints.

CASE XXXIII. Rédard (*Gaz. des Hôpitaux*). Infant, aged twenty months, with subluxation of right knee and patella ab-

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sent; thigh was atrophied, apparently from wasting of quadriceps, the lower part of which seems transformed into fibrous substance.

CASE XXXIV. L. A. Sayre (*Internat. Congress*, Berlin, 1890). New-born girl, with absence of one patella; left knee hyperextended so that the toes touch the abdomen. A rudiment of right patella was first noticed at nineteen months.

CASE XXXV. Brünner (*Virchow's Archiv*, 1891). A young man, aged twenty years, walked well and far, but was slightly unsteady. Both knee-caps were absent, and he had a slight varus; no other deformity.

CASE XXXVI. Phocas and Potel (*Rev. d. Orth.*, Paris, No. 5, 1896). A girl, aged three years, with double talipes and slightly impaired motion in flexing the knees. Both patellæ wanting.

CASE XXXVII. A. T. Bristow, of Brooklyn (*Medical News*, January 2, 1897). A child, aged two and a half years, unable to walk or stand. Knees somewhat loose, with some abnormal lateral and rotary motion. The knees flex only 40°; both patellæ wanting.

CASE XXXVIII. Julius Wolf (Hoffa's *Orthopädische Chirurgie*, 1891, p. 581). Left patella absent in a girl, aged nine years; the knee is held in subluxation by a triangular fold of skin and fibrous tissue. Varus of right foot, syndactylism. A plastic operation; result, a useful knee.

CASE XXXIX. Mr. Adams' unpublished case (quoted by E. M. Little, in *Lancet*, September 25, 1897). Boy, with absence of both knee-caps and double varus. Hereditary on the father's side.

CASE XL. E. M. Little (*loc. cit.*). Girl, first seen when three months old, with hyperextended knees which could not be straightened beyond a straight line, and double talipes equino-varus. The father, uncle, and grandfather were born without knee-pans and

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with club-feet. When two years old she could stand with hyperextended knees. At three and three-quarters years the right knee-cap was felt; the knees were very lax. When nine years and eight months old she could run and dance without difficulty; slight hyperextension was possible, but when standing or walking the knees did not pass the straight line.

CASE XLI. Idem (*loc. cit.*). A sister of preceding had almost the identical condition present in both knees and feet. When five years and ten months old she could run about actively. The patellæ were small and scale-like; a skiagraph showed that ossification had not begun. The knee-joints were loose and allowed more lateral and rotary motion than normal. Slight force would produce hyperextension.

CASE XLII. Idem. Boy, aged six weeks, right patella absent. Left knee capable of hyperextension, but flexes to the normal degree; the right knee is hyperextended and stiff. Condition not hereditary. The patella appeared between the age of two and two and a half years. Child walked well when five years old, and the knee could flex a little beyond a right angle.

CASE XLIII. Dr. Alex. Friedleben, of Frankfort (*Jahrbuch für Kinderheilkunde*, 1860, iii. p. 220, and in Schmidt's *Jahrbucher der Medicin*, 1861, vol. cxii. p. 307). Multiple malformations, including absence of both femoræ, patellæ, and fibulæ. The third child of a strong, healthy mother, was born by a difficult version, the arm and shoulder at first presenting. It died when thirteen months old, after convulsions. At autopsy, the head, chest, abdomen, and arms were well formed, except that the right upper arm was longer than usual, the forearm very short, and the hand only had three long, slender fingers. The deformed pelvis and limbs were alike on the two sides; at the cartilaginous union of the os pubis, ilium, and ischium there was no trace of an acetabulum; but a short, dense, fibrous band into which the thigh muscles were inserted joined this region to the knee, where this fibrous band broadened out into a cartilaginous lower femoral epiphysis with ossific centre. This mass, however, was firmly

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fused to the upper epiphysis of the tibia, in which was another centre of ossification; no ligaments could be demonstrated; the tibiæ pointed inward, and on cross-section were almost round. No vestige was found of the fibulæ or patellæ. There was right talipes varus, left equinus.

CASE XLIV. William B. Hopkins (*Annals of Surgery*, 1897, vol. xxv. p. 197). A man, aged sixty-eight years, with absence of both patellæ; the knees admit of slight hyperextension; motion is slightly restricted in extreme flexion; no paralysis; walks well and far.

CASE XLV. Arthur H. Burgess (*Lancet*, October 2, 1897). A girl, aged six years, with absent right and rudimentary left patella. The knees hyperextend 20°; the right can be bent about 10° in flexion; the left only to the straight position; in this position there is evident genu valgum. The girl walks without aid in spite of double congenital dislocation of hips; right talipes equino-varus and left calcaneus valgus.

CASE XLVI. Harold N. Mayer (*Lancet*, 1897, vol. ii. p. 1384). An idiotic man, with multiple deformities. Both patellæ are wanting, and he has anchylosis of both knees at a right angle; also a large asymmetrical head; facial asymmetry well marked, the right eye and ear much smaller; double thumbs, rudimentary fingers, undescended testes, and double club-foot. Has been exhibited at shows, as the human bear, on account of his peculiar gait.

CASE XLVII. G. S. Samuelson, of Armidale, New South Wales (in *Lancet*, December 11, 1897). Both patellæ were absent in a girl, aged five years. She is unable to walk without assistance. Extensor tendon is thin and very narrow toward its insertion in tibial tuberosity. Knees hyperextend 45° and flex only 25°. Family healthy. Attributed cause, maternal impressions.

CASE XLVIII. Bosquet (*Bull. Soc. de Chirurg. de Paris*, 1885, n. s., vol. xi. p. 354). Young man, aged twenty-one

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years ; slight knock-knees ; the right patella as small as a plum-stone, lying upon the outer condyle, the left absent. A good walker. The knees are very broad and flat.

CASE XLIX. Menard (*Revue d'Orthopédie*, March, 1893, p. 114). Boy, aged four and a half years, with absence of both patellæ and congenital dislocation of right hip. Runs and walks well ; the peculiar gait is due to hip luxation. The quadriceps femoris on both sides is small and weak.

CASE L. E. O., seen October 20, 1897, aged fourteen months. Both knees flat in front and are at times voluntarily hyperextended about 30°. The usual position of the limbs is straight. About 20° flexion is allowed. No muscular spasm or paralysis.

CASE LI. R. E. J., a girl, aged seven months, with left lower extremity deformed by absence of the femur, patella, fibula, and outer arch of foot. Right lower extremity and entire upper part of child well formed. Left side of pelvis appears to be developed symmetrically, but the knee lies directly under the iliac crest and is capable of motion. There may be a half inch of femur, but palpation is difficult. The outer arch of the foot and the fibula are wanting ; the great and second toes are fused. A well-marked rosary of rickets exists.

It appears from the table that the sexes are evenly divided, and the deformity occurred in twenty-nine cases bilaterally and in twenty-one unilaterally (thirteen left, six right, and two side not stated). Of the twenty-one unilateral cases eight had a rudimentary patella on the other side, of which four were adults, three children, and one an infant. It is not improbable that some of these rudimentary patellæ represent a late development of the bone. Bilateral absence is, therefore, more common than unilateral.

Little found in nine cases, by various writers, the knee-cap appeared at ages varying from six months to six years. In his own experience delayed development was the rule, and it is, perhaps, significant that more than one-half of the cases here tabulated

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were infants under two years of age, some of whom certainly developed knee-pans later. At least 18 per cent. are positively cases of delayed formation. Only eight men, or 16 per cent., had attained their growth, and can fairly be regarded as bereft of the chance to grow a patella.

Among the congenital deformities which accompany this condition, congenital club-foot predominates, occurring in twenty-four cases; other forms of talipes in five; congenital dislocation of the hip in five; club-hands, syndactylism, absence of fingers or toes, absence of fibula each occur several times. Several of the unilateral cases exhibit malformations of one limb only, as if something had interfered with the normal development of the limb. The malformations of the knee are at times very extensive, as in Friedleben's case and the writer's, in which the shaft of the femur is wanting and the knee obliterated by fusion of the lower femoral epiphysis with the top of the tibia. Kroenlein reports a congenital anchylosis in hyperextension; Pello multiple anchylosis, including both the knees. By far the commonest condition is a general laxity of the ligament allowing hyperextension and abnormal rotation and lateral movements, the amount of hyperextension varying from a few degrees to complete forward dislocation. It was noted in one-half of the cases. In several the knee could not be bent beyond the straight position; in others it would flex less than a right angle; but this condition is frequently outgrown or remedied by treatment. Genu valgum occurred several times with the forward knees. It is needless to add that the forward knee, genu recurvatum, occurs with a patella as well as without. It is frequently associated with contraction of the quadriceps, so that the leg would snap back after straightening, as if by a spring. In the flexed knees hamstring spasm also occurs, with resulting subluxation in Redard's case, due to faulty insertion of the quadriceps, and in Körte's to paralysis. Actual paralysis of this muscle, although not commonly noted, is considered by Phocas as one of the causes of the deformity; nevertheless, as he also points out, the patellar cartilage is formed in the third month of fœtal life, whereas active movements of the fœtus only begin in the fourth month.

Little has, however, established the influence of heredity. He quotes Mr. William Sedgwick's note of "a family in four genera-

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tions of which eighteen persons had no patellæ and no thumb-nails." Many cases, however, do not furnish the history of an inheritance, and are simply due to lack of development.

Prognosis depends upon the sort of knee-joint in a given case. The condition of the joint varies, but there is considerable impairment of function in *early* life. Of the eight adult cases, one "walked many miles without difficulty;" the second "walks miles and is on her feet all day;" third "goes downstairs and down hill cautiously, fears a fall if carrying anything heavy;" fourth has a "tabetic gait, and is easily fatigued;" fifth "totters a little in walking;" sixth, "walked well and far, slight tottering;" seventh, "walks well without fatigue;" eighth, "a good walker;" the ninth has anchylosis with flexion of both knees and club-feet; he is able to get about a little. If one except anchylosis and disabling deformities in other bones or joints, the prognosis for a useful limb is good in all cases in which the quadriceps tendon is inserted into the tubercle of the tibia. Where, as in Mueller's case, this fails, and if the sartorius remains, a simple orthopedic splint will make locomotion possible, or if the quadriceps retains its power the insertion may be corrected by freeing the tendon and attaching it to the periosteum of the tibia, as Goldthwait has recently done in a case of congenital misplacement of the patellæ. This case is not yet published.

In childhood much can be done to assist nature in her efforts to form a useful knee by a light, jointed splint which will restrict the joint motion within its normal limits and prevent the stretching of the loose ligaments by the body-weight applied in faulty positions. Flexing hyperextended knees and applying a stiff bandage have also been followed by a rapid appearance of the patella and tightening of the slack ligaments. In young infants the lightest sort of splint or bandage which prevents abnormal joint motion is the proper treatment.

The following conclusions may be summarized:

1. It occurs irrespective of sex.

2. It is more commonly bilateral than unilateral.

3. In a good many cases the patella is formed late; it appears between the sixth month and seventh year.

4. It is often accompanied by other deformities, as club-foot,

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congenital dislocation of hips, forward dislocation of knee, club-hands, absence of other bones, as the fibula or femur, or multiple anchylosis of the joints.

5. Paralysis may be present, but is hardly considered a predisposing cause.

6. A congenital lengthening of the ligaments of the knee is often present in early life, permitting hyperextension, lateral mobility, and rotation, and giving rise to considerable loss of function.

7. Absence of patella in adults usually gives a fairly serviceable knee with some impairment of power and motion.

8. The prognosis must be based on the actual condition of the knee and the age of the patient, and be modified by coexisting deformities.

9. Heredity undoubtedly acts as a predisposing cause in many cases. Blows on the pregnant abdomen and maternal impressions have also been regarded as having something to do with its occurrence.

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ON THE PREVENTION AND CORRECTION OF SHORT LEG IN HIP DISEASE.

By ROBERT JONES, F.R.C.S E.,
LIVERPOOL.

No matter what care be taken in the early treatment of hip disease a certain amount of deformity seems inseparable from a large number of cases. The percentage is variously stated by different authors to between seventy and eighty. Doubtless certain factors tend to lessen this estimate, prominent among which one would place the early diagnosis and treatment and the efficient mechanical control of the limb. In my own practice I am obliged to admit that until lately in a proportion of cases (certainly small), even where a patient has been presented to me without appreciable deformity, I have been powerless to prevent shortening. That my experience is not unique is proved by the literature of the subject and by the continued efforts made by surgeons at home and abroad to devise methods for the prevention of short leg. Of one thing we may rest assured: that, however effectually we may modify by mechanical means deformity in active arthritis, much more radical measures are required where the joint is sound, but anchylosis and deformity remain. It is with the view of endeavoring to simplify the methods of preventing adduction and to facilitate its correction, once it has occurred, that I submit this short statement for your consideration.

The deformities which constitute short leg comprise all or most of the following conditions, viz.: flexion, adduction, internal rotation, tilting of pelvis, and arrest of growth. The first four of these conditions, viz.: flexion, adduction, internal rotation, and tilting of pelvis, I venture to think may in the future be avoided where we have an early case to deal with. Obviously we can only modify the shortening effected by arrest of growth by deflecting the pelvis sufficiently to insure apparent equality of the limbs. Without entering

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into a discussion as to the causes, I would state that, contrary to the teaching of surgeons, it often occurs without the complication of abscess, that it often occurs very suddenly, and that in quite a number of cases it happens in robust children and is absent in the weakly and emaciated. I would further add that, though abduction is usual in the so-called first stage of the disease, I have frequently noted, in cases with what one may call a strongly deforming tendency, that adduction is present almost from the first, and that abduction has not once been noted in the so-called first stage. Again, one must recollect that adduction may occur without tilting of the pelvis and without displacement of the femoral head. In proof of the fact that body-weight is not the all-important factor in the production of deformity, as many authors would have us believe, one has only to adduce the fact that the whole series of elements which make for short leg may appear while the patient is lying in bed.

The best routine appliance for hip disease is undoubtedly the Thomas splint, and I always use it in those cases where it is sufficiently effective to control deformity. One generally, for this purpose, should employ the abduction body-wing, and should thoroughly master the not easily nor generally acquired art of its application. In some cases, however, where the structures about the joint seem to thicken early and glide backward, I am using a special abduction splint (Figs. 1 and 2). The new splint is so designed as to keep the diseased limb fixed in the abducted position, and it effectively prevents any elevation of the anterior superior spine on the sound side; it governs rotation, flexion, and adduction, and, in my belief, solves the problem of the prevention of short leg, for by its help I can with confidence predict in every early case that recovery will take place without shortening, provided we have not to deal with arrested growth. The importance of this assurance will be appreciated when we note that while shortening occurs, in say 70 per cent. of cases, arrest of growth to any but a barely recognizable extent occurs in not quite 15 per cent. This arrest I find is usually not confined to the femur, but is shared by the other bones of the limb.

In a discussion held lately at the clinical society at which I was present, Mr. Watson Cheyne, in order to emphasize an argument, stated, "No one would ever think of immediately straightening a hip or knee during any stage of tubercular activity." Mr. Barker

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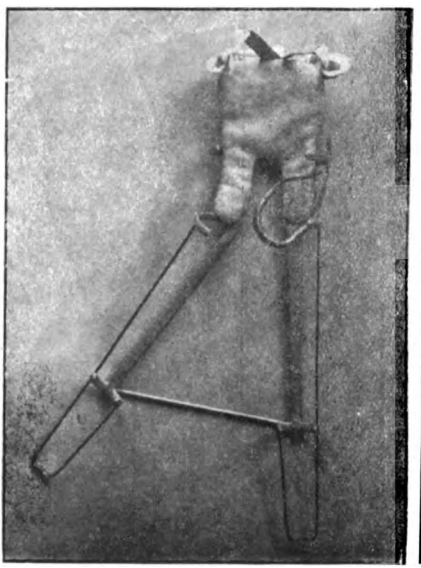
took a similar view, and referred to the dangers of general infection. In a later conversation with these gentlemen I fully realized the wide difference there exists between metropolitan methods and those I have been accustomed to follow. In the practice of the late Mr. Thomas, in that of Mr. Rushton Parker, and in my own, it has always been the custom to rectify, with varying degrees of force, any tubercular joint in wrong position, so far as the phrase might be applied to the deformity known as flexion. I should scarcely like to

FIG. 1.



Author's abduction splint.

FIG. 2.

Showing patient in abduction splint.

guess how many hundreds of such cases have passed through my own hands. Not only have I never waited for recovery to take place from the tubercular process as a preliminary condition, but I have looked upon the active stage as that most appropriate for reduction on account of the great facility with which it may be effected. In the case of the knee particularly I commonly reduce an angle of 30 to 40 degrees, and allow the patient to travel home the same morning, sometimes a considerable distance. I am not aware that my statistics are in the least harmed by such seemingly rude methods;

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on the contrary, I have every reason to be more than satisfied with the results. In the case of the hip, even extensive flexion deformity does not shorten the limb to nearly the extent that adduction with pelvic tilting does, and I have for some time directed my chief attention to the prevention or displacement of the head and to keeping under control the level of right and left anterior pelvic spines.

FIG. 8.

Five and a half inches practical shortening.

My practice now in all cases of displacement of the head is to endeavor at once to reduce shortening by force sufficient to effect this end. If this be attempted while disease is active and before anchylosis, fibrous or bony, has had time to take place, scarcely any difficulty is experienced, and the pulleys have rarely to be used. This, of course, refers to the case of children. The force that governs the displacement generally suffices to rectify pelvic obliquity, while the flexion can be overcome at the same time by ordinary methods. If

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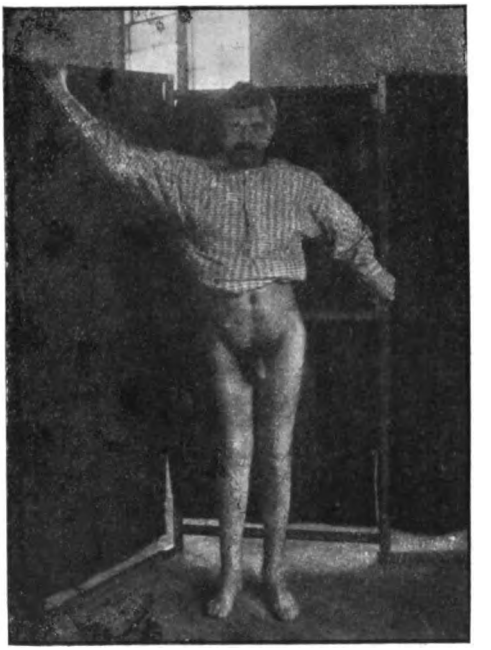
the case be of long standing and the structures around the hip-joint are much thickened, two or three applications of the pulley may be required at intervals of about a week. In cases where the tubercular process has subsided and anchylosis remains, certain other procedures are necessary, and will be described further on. Having restored, as far as possible, the displacement of the hip and the

FIG. 4.



After transtrochanteric osteotomy.

length of the *limbs*, the patient is placed in the new abduction apparatus, where, as I have stated, the parts are so combined as to effectively prevent the slightest tilting of the pelvis in any but the direction of advantage to the diseased side. The patient is maintained in this until that phase of disease productive of deformity has passed. When the disease admits of it he may be transferred to an ordinary walking splint, the abducted limb meanwhile being brought

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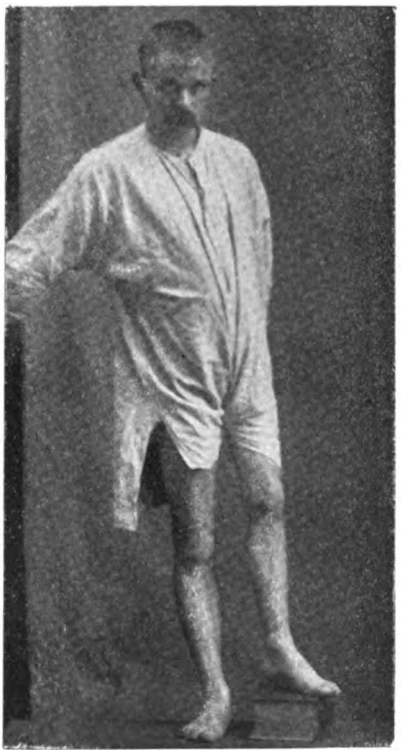
into its proper position, but practically during the whole of treatment he should live in the open air. I am quite convinced that this abduction splint is an effective preventive of adduction, from my own practical experience, but, if further argument were needed, it is supplied by the fact that without recourse to force one can by its use

FIG. 5.



Practical shortening four inches.

gradually overcome any moderate amount of shortening that may be found to have occurred in a recent case. If it can correct deformity it can much more easily prevent it.

I would now deal with another important class of cases. I allude to those cured of their hip disease—some children, some grown-ups. They may have shortening varying from two to six or seven inches,

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due to femoral displacement and oblique pelvis. I have operated already upon about fifty such cases, and can speak most hopefully of results; and here it may be well to mention, if we are to keep anything like an accurate record of these deformities, we should employ a simple method of measurement for fixing the degree of adduction and estimating practical and real shortening.

FIG. 6.

After transtrochanteric osteotomy. No practical shortening.

Osteotomy, as we know, has been practised for years to overcome the deformity of flexion. Rhea Barton performed it in 1826, and he was soon followed by Clemmot, Rodder, Maisonneuve, and others. Adams first performed the operation subcutaneously. He divided the neck of the femur. The other operators worked lower down, but only Gant divided below the lesser trochanter. Probably Gant's operation is the most popular to-day; but, personally, I prefer that of Adams if we only have to deal with the deformity of flexion. Although something must be said in favor of a section that cannot

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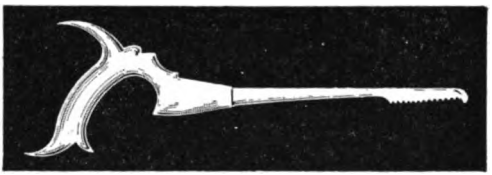
be interfered with by a shortened psoas and iliacus, yet I have found that in cases of right-angled deformity of the hip the upper part of the femur left fixed after Gant's incision has an ugly way of encroaching upon Scarpa's triangle. Of this I am also certain, that

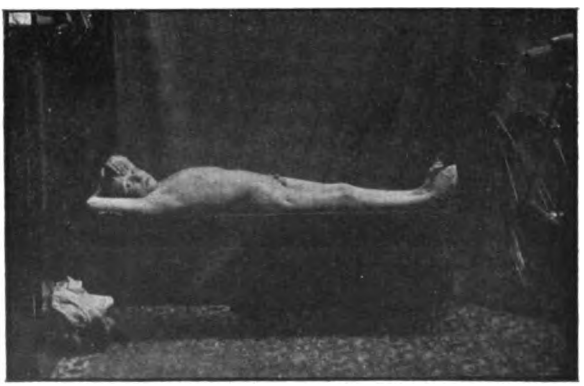
FIG. 7.



Author's modification of Adams' saw.

even if an osteotomy incision be made through inflamed tissue, as must sometimes occur in Adams' operation, union is not in the least hampered. Personally, with a view of not merely rectifying a flexion angle, which has been the general object of a femoral osteotomy, but with the intention of lessening or obliterating adduction

FIG. 8.



Shows the apparent lengthening by pelvic depression of leg, which was four inches short.

with pelvic tilting, I make my incision obliquely through the great trochanter. (Diagram F.) This involves hard work often, because of the thickness and the sclerosed condition of the bone. The work is much facilitated by having a small knob on the end of the saw, such as one which Weiss has made for me (Fig. 7). One can saw with

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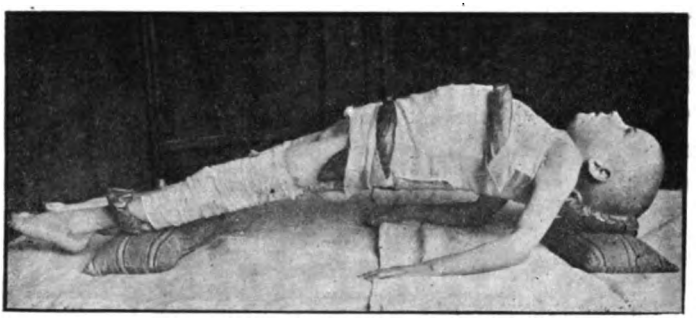
FIG. 9.



Author's splint for maintaining lordosis.

much more energy when there is no danger of either transfixion or of losing one's place. It is better, where practicable, to saw completely

FIG. 10.

Four inches practical shortening.

through bone rather than a certain distance, and I prefer going through the trochanter because of extra callus exudation, as an un-

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united fracture will spoil the intention of the operation. The adductors are next subcutaneously divided, and, in the case of a youth or adult, traction is applied by means of pulleys. Very often an inch or an inch and a half may be gained by this traction (Diagram F), and in this way some of the shortening of actual displacement may be combated. The leg, still fully extended, is placed in a position of abduction (Diagram G and Fig. 2), which varies with the degree of pelvic

FIG. 11.

After osteotomy and abduction. Line shows how pelvis has been lowered on diseased side and shortening obliterated.

tilting. The greater the tilting the greater should be the abduction. The pelvis on the sound side is fixed, and the abduction splint is applied, and extension and abduction are maintained. (Fig. 2.) Seven or eight weeks are allowed to elapse, until, in fact, bony union is completed, with the limb in abduction and at an angle with the body.

It is now to be noted that the length of the limbs may be equalized in one of two ways, or by a combination of both: by either

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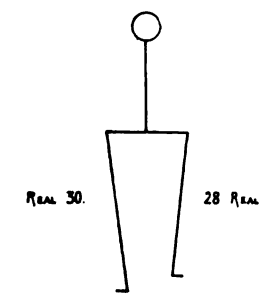
lessening the practical length of the sound limb or increasing that of the short one. By osteotomy and extension the leg is actually lengthened (Diagram F). By the osseous union of the femur in abduction with the pelvis, the elevation of the pelvis on the opposite side is effected.

With an outstretched thigh in one piece with the trunk, it is clear that the limb can only be adducted at the cost of elevating the pelvis on the sound side, and in this way several inches of shortening may be remedied.

A more difficult class of case to deal with is that where short and firm fibrous union obtains. In such cases I am accustomed to divide the adductors, extend. and forcibly abduct, and if attempt at lateral movement threatens fracture I perform an osteotomy, as if for bony anchylosis; indeed, it is better in such cases to proceed forthwith with osteotomy rather than complicate the issue by forcing the fibrous bands.

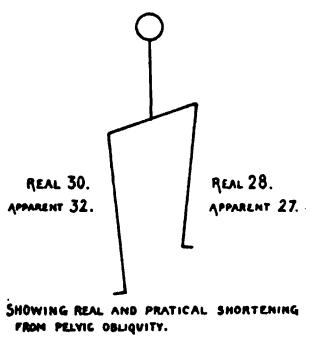
Such cases require to be kept much longer in a splint than do those where the fixation is bony, and in two or three instances, from a want of experience in this matter, the early removal of restraint has resulted in some return of deformity. One might suppose that this fibrous union would still allow the adductors to act, no matter how long the restraint and stretching. This is not so, provided sufficient abduction is obtained to counteract any subsequent slight fibrous contraction.

DIAGRAM A



SHOWING 2 INCHES REAL SHORTENING

DIAGRAM. B. TILTING. OF PELVIS.



SHOWING REAL AND PRATICAL SHORTENING FROM PELVIC OBLIQUITY.

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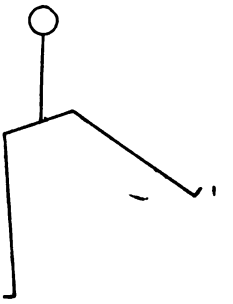
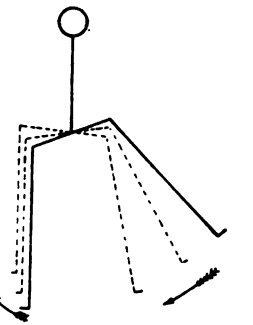
DIAGRAM C



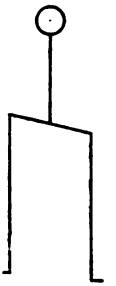
POSITION OF LEG AFTER TRANS TROCHANTERIC OSTEOTOMY.

DIAGRAM D



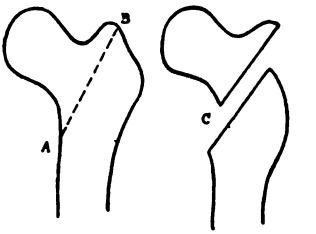
SHOWING ELEVATION OF PELVIS ON SOUND SIDE BY BRINGING ABDUCTED LEG INTO POSITION.

DIAGRAM E.



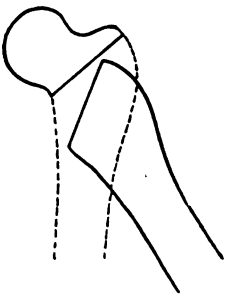
SHOWING FINAL RESULT WITH ADDUCTION OF LEG AND ELEVATION OF PELVIS OF SOUND SIDE

DIAGRAM F



A.B. LINE OF SECTION THROUGH TROCHANTER.
C. LENGTHENING AFTER TRACTION.

DIAGRAM G.



POSITION OF FRAGMENTS WHEN LIMB IS ABDUCTED.

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If the limb be abducted for a sufficient length of time further contraction is not likely to occur, and this accords with what one may assume to be a surgical axiom, that a deformed limb due to arthritis retains the same degree of movement after correction as it possessed before, and that if anchylosed at the moment of rectification it is equally anchylosed when reduction is completed.

When the splint has been removed the patient should be confined to bed for some time, until the abducted limb is gradually brought into position, and exercises should be prescribed designed to elevate the pelvis on the sound side and depress it on that of the diseased. These exercises are very necessary adjuncts, and, in the case of adults especially, they materially improve the character of the walk.

I do not now enter into the question of pseudo-arthrosis except to state that its results in my hands are most uncertain, and that by its attainment the rectification of deformity is not at all complete. I now almost exclusively employ it for the relief of double anchylosis. Of the fifty cases of bony anchylosis upon which I have operated by the transtrochanteric osteotomy with abduction, I will merely briefly state that in most the practical shortening has been obliterated and that in the rest it has been lessened almost to the point of disappearance. Suppuration has not occurred, nor have there been any symptoms of gravity. The pain, which in my earlier cases was marked, one has learned to avoid by careful adjustment of the groin-strap. In two cases tubercular abscess has presented, but in both the operation was performed during active disease. The general health, notably as evidenced by sleep and appetite, has been well maintained.

In conclusion I would sum up:

For the prevention of short leg I suggest:

(*a*) That abduction of the diseased limb should be maintained.

(*b*) That the apparatus to attain this should also govern flexion and adverse pelvic tilting.

(*c*) That where arrest of growth threatens, pelvic obliquity should be summoned to assist.

(*d*) That where displacement of the head has occurred immediate reduction should be attempted.

For the correction of short leg with bony anchylosis:

(*a*) That oblique transtrochanteric osteotomy should be performed.

(*b*) That the adductors should be subcutaneously divided.

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(*c*) That the limb should be placed in the position of abduction and extension and kept there until firm union occurs.

(*d*) That after union the splint should be removed and the limb allowed to slowly leave the abducted position.

(*e*) That exercises should be systematically done in order to depress the pelvis toward the affected side.

(*f*) That in cases of fibrous anchylosis where no osteotomy has been performed the abduction should be maintained for considerably longer in order to avoid recurrence.

(*g*) That this treatment should, as much as possible, be carried out in the open air.

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TWO CASES OF SPASMODIC TORTICOLLIS; ONE CURED, THE OTHER MUCH RELIEVED, BY MECHANICAL TREATMENT.

By HERBERT J. HALL, M.D.,
MARBLEHEAD, MASS.

Case I. Miss R., aged thirty-eight years, dressmaker. Family history and previous history negative, except that when she was about twenty years old the patient is said to have had a number of "falling fits."

For a year previous to the attack of torticollis she worked very steadily at the sewing-machine.

In July, 1896, she first noticed slight stiffness and an occasional twitching in the muscles of the neck. The spasms grew worse so rapidly that in two weeks she was obliged to give up all work. She was treated for a short time by a physician who tried sedatives without effect.

December 2, 1896. On this date, a little over five months from the time of the onset, the patient was first seen by the writer. She had been in bed for several days, unable to sit up or to go about the house without extreme annoyance from the spasm. Physical examination showed a well-developed and nourished woman, rather under middle height. No abnormalities were discovered except a severe clonic spasm of the right sternomastoid and left posterior cervical rotators. The head was turned constantly to the left and markedly retracted. The deviation from the normal would often terminate with the face looking directly upward and the chin over the left shoulder.

It was observed during the examination that a firm grasp of the hand on the nape of the neck would greatly diminish the spasm.

December 7, 1896. The spasm was at once decreased and is now nearly controlled by the application of a spring-clamp to the back and sides of the neck.

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The clamp is very simple in construction and does practically what the thumb and fingers do in grasping the neck from behind. It is of light spring-steel, broader, but otherwise similar to the ordinary trouser-guard worn by bicyclists. There is a tail-piece running from the middle of the spring about six inches down the back. When the clothing is buttoned tightly over it this tail-piece helps to keep the spring closely applied. A gentle pressure is thus exerted on the back and sides of the neck as far forward as the anterior borders of the sternomastoids. The results were best when the collar was worn at about the level of the angle of the jaw. The application of this simple apparatus instantly stopped most of the twitching, although the symptoms would at once recur upon removal of the pressure.

January 1, 1897. The apparatus has been worn constantly, but it can now be discarded for several hours a day without recurrence of the spasm. There is still some rigidity and a slight tendency to clonic spasm in the affected muscles. This rigidity is responsible for a slight fixed torticollis.

December 3*d*. On account of his interest in these cases, the patient was sent to Dr. George L. Walton for observation and prognosis. Dr. Walton referred the case to Dr. F. I. Proctor, who later reported astigmatism and obliquity of the axis of vision in both eyes. Glasses prescribed.

January 20, 1898. Neither clamp nor glasses have been worn for several weeks. Patient does a little sewing and attends to ordinary household duties without inconvenience. She has taken several long walks. There is a slight torticollis of a fixed and painless nature due to a permanent contraction of the affected muscles. She turns her head freely in any direction.

SUMMARY OF CASE I. A severe spasmodic torticollis of five months' standing was at once relieved and has remained under control for a year and a half by the simple expedient of spring-pressure on the cervical muscles. For several weeks the spasm recurred on removal of the apparatus, but later no appliance was necessary. The affection was brought under control in spite of the existence of marked ocular defect. No drugs, no exercises, no massage or electricity, no complicated fixation apparatus were used in bringing about the desired result.

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CASE II. Miss F., aged thirty-two years; shoe-shop hand. Referred by Dr. Herbert W. Newhall, of Lynn.

Family History. Negative.

Previous History. Always reasonably well until present attack.

Duration of symptoms five weeks. Gradual onset, without pain.

The patient has worked for five or six years in a shoe-shop, doing the same work always, which requires the constant use of a light hammer, pounding on the leather.

February 29, 1898. Physical examination shows a young woman of medium height and rather slight build. Nothing abnormal was observed except the severe spasm, which kept in constant action the right sternomastoid and left posterior cervical rotators. The motion of the head in this case was very similar to that observed in the one just reported, but it could not be so readily controlled by the hand grasping the neck.

A reasonably good prognosis was given, however, and measurements taken for a spring-collar.

March 6th. The clamp has been worn one week, and there is plainly an improvement, although the spasm is still very severe.

Treatment continued and supplemented by a series of Delsarte movements designed to limber up all joints and to bring about a relaxation of all the muscles of the body, especially of the muscles of the neck.

Strangely enough, the exercise which seemed to relax the neck most was one in which the hands were shaken violently and loosely on the relaxed wrists.

30th. The head can now be held straight for a brief time, and the existing spasm is less severe. A Thomas collar stuffed with oakum has been substituted for the clamp, which, though padded and covered with chamois-skin, has caused chafing.

April 12th. There has been very decided improvement remarked by every one who sees the patient. The twitching, although it does not carry the head so far or so forcibly, is still annoying, and various forms of head-support have been tried, without relief. The patient herself decides to go back to the collar as being of the greatest service. The patient's day has been plotted out carefully into periods of rest and exercise. New exercises have been introduced which tend to develop the entire body. She can now

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voluntarily relax the tense sternomastoid. The eyes have been examined by Dr. Cobb, of Lynn, who finds in this case also astigmatism and oblique visional axis.

May 1st. The spasmodic motions have almost wholly ceased. Neither collar nor glasses are worn constantly. She cannot turn her head beyond the middle line to the right, but it can be held very nearly front without difficulty. A slight tonic contraction of the right sternomastoid turns the head persistently a little to the left. There is no retraction. Much walking or over-exercise of any sort causes pain in the left shoulder. The patient has not, from the first, been allowed to use her eyes for reading or sewing. To-day she admits that she has read a short story, but without relapse.

30th. Slight improvement from last note. The patient is very very cheerful, and expects to be able to turn her head freely in any direction before long.

SUMMARY OF CASE II. A second severe case of spasmodic torticollis of five weeks' duration somewhat relieved at once, and in three months practically cured by the spring-clamp, supplemented by a careful system of gymnastics designed to relax as well as to develop all muscles, and especially those of the neck. Very little attention was given to the development of the muscles directly opposed to those involved in the spasm. The exercises were designed to improve the general poise and to secure good muscular control throughout the body.

GENERAL CONSIDERATIONS. The experience of the men in this vicinity in dealing with this disease has been rather unsatisfactory. Some cases have been passed along from general practitioner to orthopedist, to neurologist, from him to the ophthalmologist, and finally to the general surgeon; all this, perhaps, without improvement. When other means fail, the general surgeon stands ready to do neurectomy on the spinal accessory and the posterior cervical branches. Even then, with all the posterior rotators and the sternomastoid divided, the twitching may not cease.

This most persistent and annoying spasm is not accompanied by any structural changes either in the nerve-trunks or in the nerve-centres.[1] It seems, therefore, to some extent psychic or mental.[2]

[1] Gowers. Diseases of the Nervous System, vol. ii. p. 669.
[2] P. Redard. Le Torticolis et son Traitement, p. 119.

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Referring presumably to complete fixation, Richardson and Walton state that "mechanical support to the head has proved not only inefficacious, but unendurable, the restraint only adding to the discomfort and tendency to spasm."[1] They also refer to a case temporarily benefited by massage. Drugs, electricity, and nerve-stretching have proved of no value.

It is certain that some cases must come to operation; nothing else will put a stop to this misguided activity which, though usually painless, is so fatiguing and annoying that the patient gladly welcomes the most severe surgical measures.

The operation as practised by Dr. M. L. Richardson is very complete. The results in the cases which Dr. Richardson and Dr. Walton have seen are certainly excellent, although a second or even a third operation has sometimes proved necessary, as the spasm is transferred to new sets of muscles. It is this rapid transference—for instance, from the sternomastoid to the posterior rotators of the opposite side—which is the worst objection to operation.

On the other hand, mechanical support is capable of a wider field than mere fixation, as by the plaster helmet or a rigid head-support of any kind. Dr. A. T. Cabot has one case of cure by the plaster helmet, but for the most part such treatment is absolutely unbearable. The pain becomes severe, and when the restraint is removed the spasm returns, so much increased as often to cause muscular strain of serious proportions. Supports of wire from the shoulders, of such construction as to resist the spasm by means of stiff springs against the side of the head, do some good, but do not seem to have brought about permanent improvement. Why the simple spring-clamp which the writer has used should succeed so well in these cases cannot be given a clear explanation. A study of the contractions of spasmodic torticollis in their resistance to various restraining forces has convinced the writer that very mild pressure applied properly at the back and sides of the neck by the hand or a simple clasp of metal will give better control of the motion of the head than will any method which disregards the neck and seeks to hold the head itself. This is easily verified by

[1] Richardson and Walton. "The Operative Treatment of Spasmodic Torticollis, with Cases." The American Journal of the Medical Sciences, January, 1895.

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trying it on the voluntary motions of a normal neck. Besides this, the skull on account of its rounded surface is difficult to hold. Control by pressure on the neck allows a fair amount of freedom to the head, a factor which is apparently necessary to success. Probably there are cases which will not yield at all to such measures as these, but the results which this paper records are certainly encouraging and should lead to an extended trial of the methods suggested.

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A CASE OF THREE FLOATING CARTILAGES IN THE KNEE-JOINT PRESENTING PECULIAR SYMPTOMS.

By LeROY W. HUBBARD, M.D.,
NEW YORK.

Miss G. L. S., aged fifty years, school teacher by profession. Enjoyed good health up to sixteen years of age. At that time, while frolicking with a cousin, was lifted up by the arms, and the right knee gave way with a peculiar sickening feeling and sensation, as if the tibia was dislocated inward. Describes appearance as if there was a hollow on the outside of the leg. Returned to natural position without assistance.

During the next twelve years this same accident occurred at varying intervals, frequently throwing her down, and followed by swelling which lasted two or three days.

She was treated by a so-called rubber, and wore an elastic knee-cap.

At the end of this period the attack ceased, and the knee was perfectly normal until six years ago. During this interval, and four years after the attacks of so-called dislocation ceased, she suffered from an attack of acute inflammatory rheumatism, which involved all the joints, but from which she recovered, with perfect motion in this knee.

Six years ago, while out of health, stooped to open a bureau drawer; was seized with a severe pain in this knee, which caused her to faint. Soon recovered, and in an hour's time was walking about, and for a year had no trouble with the joint. Then had a similar attack, which was more severe and confined her to the bed for two or three days. From this time there was always a certain amount of discomfort in the knee, and at times a sharp pain, but not severe or lasting much time. Soon noticed that she was not able to fully extend the leg.

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Was first seen by me in April, 1896. The previous summer she had been operated upon for the removal of the uterus and appendages for extensive fibroids, and was still suffering from nervous prostration.

I found the joint flexed to an angle of 170°, and any attempt at complete extension was met with resistance of the hamstrings and sensation of discomfort in the region of internal semilunar cartilage. Complete flexion normal; no muscular spasm. No swelling; slight tenderness over inner head of tibia. Advised massage, hot water, and use.

During summer, while in the country, had several attacks of pain of short duration.

In September, 1896, found the flexion had increased slightly and increased tenderness over the region of internal semilunar cartilage. Attacks of pain more frequent, and disability lasting longer; seemed to be brought on by lateral twisting of the limb. Seen by Dr. Shaffer in consultation, who thought the trouble was in the inner cartilage and advised a support to prevent lateral motion at the knee. Applied and gave some relief and freedom from attacks, but caused a good deal of pain in muscles of thigh and leg from weight. During the summer was obliged to discard support. In the fall of 1897 was much worse, the pain and disability being more severe and prolonged. During this entire period careful examination and various tonics had failed to reveal the presence of any foreign body in the capsule or region of the joint.

In October, 1897, was seen by Dr. Robert F. Weir, who, after a careful examination and knowledge of the history of the case, was also of the opinion that the inner semilunar cartilage was the seat of trouble, and advised an operation.

November 2d joint opened on inner side, and the cartilage was found slightly thickened, but not enough so to account for the symptoms. During manipulations of the knee three floating cartilages came into view one after the other from the posterior part of the joint. These were removed, and, after careful examination for others, the wound was closed.

Convalescence was slow, owing to inflammation, and the joint is now quite stiff.

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AN OPERATION FOR UNUNITED FRACTURE OF THE NECK OF THE FEMUR.

By ARTHUR J. GILLETTE, M.D,
ST. PAUL, MINN.

On February 2, 1897, with Dr. Edward Boeckmann, of St. Paul, I saw Michael C., aged thirty-six years, who gave the following history:

On September 15, 1897, nearly five months before, he was thrown from a wagon, the wheel of which struck his hip; the injury was such that his physician kept him in bed for five weeks. It was impossible to find what diagnosis was made at the time of the injury. When he entered Bethesda Hospital he was able to go about only on crutches. Even with this protection to the limb he suffered great pain whenever the limb or foot came in contact with an object that disturbed it in the least. He suffered great pain at night, especially upon any attempt to move. He was given an anæsthetic, and a case of intracapsular fracture of the hip was easily demonstrated.

The hip was forcibly manipulated and the patient placed on a hard bed, with extension by weight and pulley, and sand-bags on either side of the limb, which treatment was continued for one month. He was then again examined under an anæsthetic, which examinatian showed that there had not been the slightest attempt at union.

Dr. Boeckmann operated, making a horseshoe-shaped incision (Fig. 1), beginning it an inch below and an inch posterior to the anterior-superior spine of the ilium, carrying it down two inches below the trochanter major, and bringing it up the buttocks to about the centre of the gluteus maximus muscle; the skin, superficial and deep fascia were dissected *en masse*. A chain-saw was then passed between the posterior border of the tensor vaginæ femoris muscle and the gluteus medius, hugging the neck of the femur and the base of the trochanter

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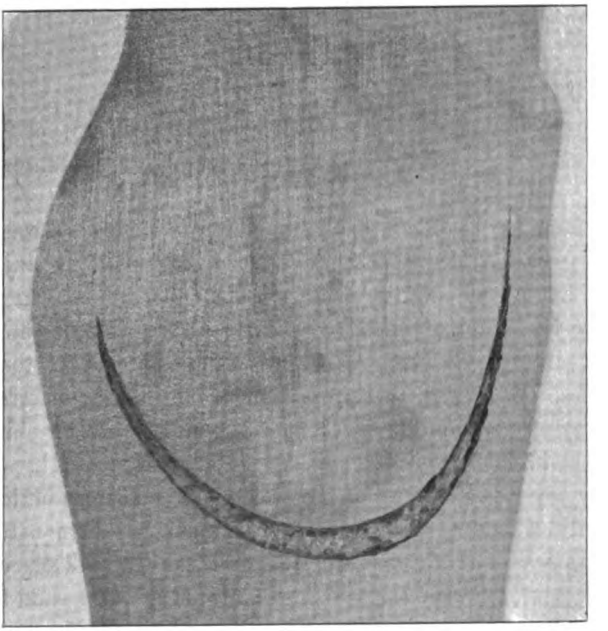
major; it was brought out between the posterior surface of the gluteus medius and anterior surface of gluteus maximus (Fig. 2), thus sawing off the trochanter major and its muscular attachments, which were then turned back, making an *exposé* of the capsule of the joint. Then, by making a longitudinal incision in the capsule of the joint, the line of the fracture through the neck of the femur could be easily seen. The surfaces of the fractured ends were de-

FIG. 1.



nuded and a bone-peg was driven through the neck of the femur (Fig. 3), thus holding the fractured ends together. The capsule was then stitched with catgut, the trochanter major nailed with a small bone-peg back to its original position, the skin and fascia-flap sutured, and a silicate spica applied.

Very little pain followed the operation, and the only constitutional symptom was a temperature for three days of 100° F. From that time until his discharge his temperature was normal.

April 5, 1897, after having been in bed for six weeks, and for

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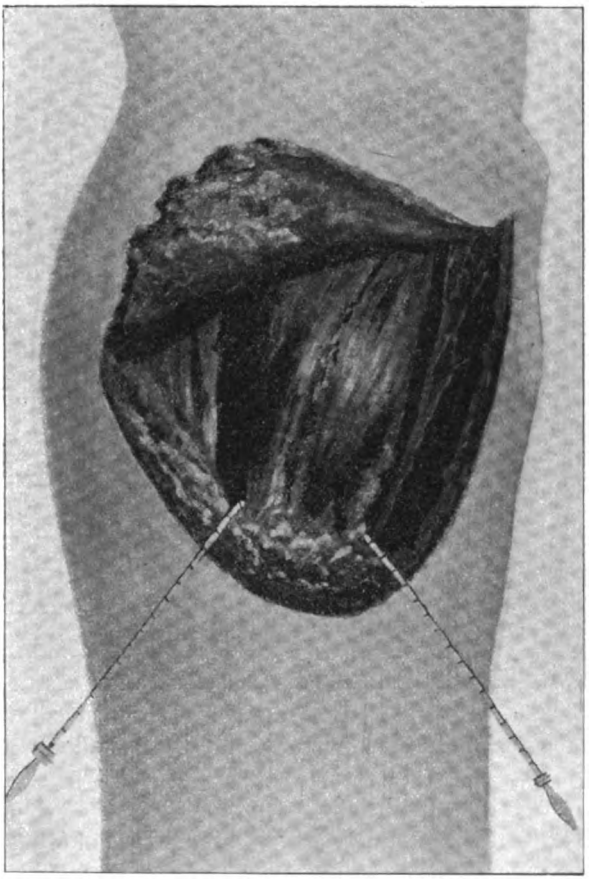
about ten days allowed to walk about the ward on crutches, and finally, with only a cane to support him, he was discharged.

I regret that the amount of shortening and motion was not accurately recorded. I can only say that at my last examination, just

FIG. 2.



previous to his discharge, I was perfectly satisfied that there was a solid union. There was no pain on motion, there was sufficient flexion and extension to enable him to walk without evidence of stiffening, and he could sit naturally in a chair.

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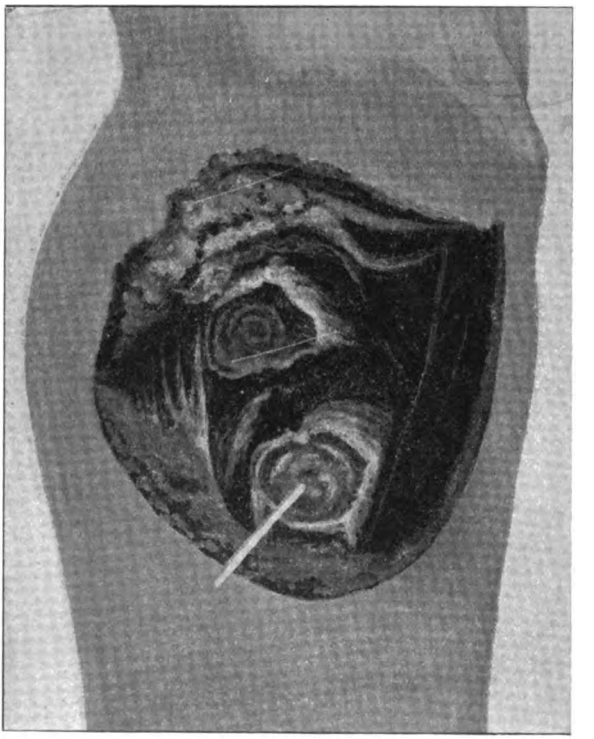
On April 16, 1898, one year after his discharge from the hospital, in answer to a letter, he stated: "I can move the leg in every direction; it pains a little when I lift it high and a little when I have

FIG. 3.



walked sufficient to become fatigued, and I am walking without a cane."

CASE II. A. L., aged thirty-six years, gave the following history:

Entered hospital, February 28, 1897, having sustained a severe injury of the hip in slipping on the sidewalk on January 5th.

The patient was placed in bed with extension by weight and pulley, which treatment was continued for about a month. He was then discharged, but because of his inability to walk and great pain, he was admitted to Bethesda Hospital, where I first saw him.

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On March 16th he was given an anæsthetic and the same operation performed as in the case just reported.

In this case it was necessary to give some morphine following the operation, as the man was very nervous and we were a little anxious as to his mental condition, as a few months previous to the injury he had been an inmate of an insane asylum. The day following the operation he had a temperature of 101.5° F., which continued to decrease, however, until the sixth day, when the temperature was normal. It was necessary to keep him in bed for about ten weeks before we were satisfied that a solid union had taken place, at which time flexion to an angle of 45 degrees could be made without eliciting any pain, and abduction and adduction were nearly normal. Considerable trouble was experienced, however, in inducing him to walk, as he had a mild attack of his former melancholia and he was fearful of the result. We were finally successful in getting him to walk with a cane. He left the hospital fourteen weeks after his admission, with a little over an inch shortening, free from pain, and walking with only a slight limp.

Within the past two weeks Dr. Earl, his family physician, reported to us that he was able to do manual labor.

Case III. On January 29, 1897, Miss Annie W., aged twenty-three years, was admitted to the City and County Hospital suffering pain in her left hip, she having one year previously slipped on the sidewalk and received an injury to the hip.

She was placed in bed for two months with splints applied, after which she was allowed to get up and go about on crutches. When she was admitted to the hospital, however, she was walking with a cane, with the foot markedly everted, and every step was attended with great pain. It was very evident she was placing little weight upon the foot, relying always entirely upon the cane. The trochanter major was above Nélaton's line; there were marked atrophy of the calf and thigh and a shortening of one and a half inch of the diseased limb. She was placed under an anæsthetic and an intracapsular fracture of the hip was very apparent.

The hip was forcibly manipulated and the limb brought down in good position. She was placed upon a hard bed, extension by weight and pulley applied, the limb slightly abducted, with sand-

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bags extending from the axilla to the foot on the outer side of the leg, and a sand-bag extending from the ankle to the perineum on the inner side of the leg, with a bandage about the sand-bags and leg. She was kept in this position continuously from the last of January to March 10, 1897. She was patient and remarkably tractable, and tried in every way to keep the joint perfectly quiet and the limb in the position desired, thus emphasizing a fact which the orthopedic surgeon already realizes, that it is impossible to hold a fracture of the neck of the femur in apposition by this means—that is by Buck's extension.

On March 20, 1897, she was placed upon the operating-table and the same incision and operation performed as in the other cases just reported, with this exception, that, instead of a bone-peg being used, a few moments before the operation it was discovered that we had no bone-pegs, so we were obliged to make a peg from the ivory handle of a surgical instrument. The subsequent dressing was also a little different: plaster of Paris was used for the spica instead of the silica dressing, and adhesive plasters were applied to the leg instead of extension by weight and pulley, when she was put to bed. Slight temperature and pain followed the operation for a few days, after which she was comfortable.

About eight weeks after the operation she was allowed to begin walking, as there was every evidence of a complete bony union. She continued under observation for nearly a year, when she left the city to accept her old position as waitress.

The following conditions were recorded: one inch shortening, extension and flexion normal, abduction normal, adduction normal, no pain or tenderness whatever, and with an elevated shoe to compensate for the inch shortening she could walk with normal gait.

DISCUSSION.

DR. SHAFFER said that he had been extremely interested in this paper, for the operation seemed to be a very sensible one. His own efforts in this class of cases had been in an entirely different line—using a traction-splint and a surcingle and pad over the trochanter. His results had also been exceptionally good.

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THE PRESIDENT asked if removal of the trochanter major was necessary in all cases.

DR. GILLETTE replied that it was much easier to insert the bone-peg if this was done, and it also afforded an opportunity to freshen the fractured ends in old cases.

DR. R. H. SAYRE said that last year he had operated upon a man who had fallen and had fractured the neck of the femur. On coming under observation a number of months afterward there was still non-union. The case was complicated by paralysis of various parts of the body, the muscles of the fractured femur being among those involved. An incision was made as if for excision of the hip, and the muscles were drawn aside. The head of the bone was firmly attached by adhesions in the acetabulum. Accordingly a gimlet was screwed into it, and it was in this way twisted loose. The ends of the bone were scraped, and by the aid of an assistant the bone was manipulated until accurate junction at the seat of the fracture took place. The gimlet was next passed through the long axis of the neck of the femur and into the other fragment of bone, and by the application of two nuts the bones were firmly fastened together. It was left in place for eight weeks. Since the operation the patient had been free from pain and could bear the entire weight of the body on the leg. There was shortening of about one inch, but he could walk well if not hemiplegic. Parkhill had recently reported a number of cases in which fractures had been "bolted" together by a peg running through the neck of the femur, being reinforced by a steel clamp running along the outside of the shaft of the femur, and fastened lower down on the shaft by two additional pegs. This surgeon has reported cases of fracture in various parts of the body in which union had been secured by this form of metallic splint.

DR. GIBNEY asked if it was necessary to freshen the edges of the ends of the fragments.

DR. GILLETTE replied in the affirmative.

DR. COOLIDGE asked Dr. Gillette what was the cause of the shortening in his cases.

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DR. MCCURDY said that he had had experience with one case of fracture of the head and separation of the epiphysis of the hip. At the operation the fragment was entirely removed, with the idea that as the ligamentum teres was ruptured there would probably be no union of the fragments, and that consequently the fragment would act as a foreign body. The neck was permitted to drop back into the acetabulum. This prevented further displacement.

DR. GILLETTE said that owing to variations in the angle of the neck of the femur, and the fact that the cases were old ones and the bones required freshening, it was not considered practicable to leave the trochanter major. He had recently employed Dr. Shaffer's method in a recent fracture with a most excellent result. As to the matter of shortening, he might ask: What causes shortening in a case of fracture of the shaft of the femur when the bones are placed in good position? Some of the shortening was probably due to absorption of bone.

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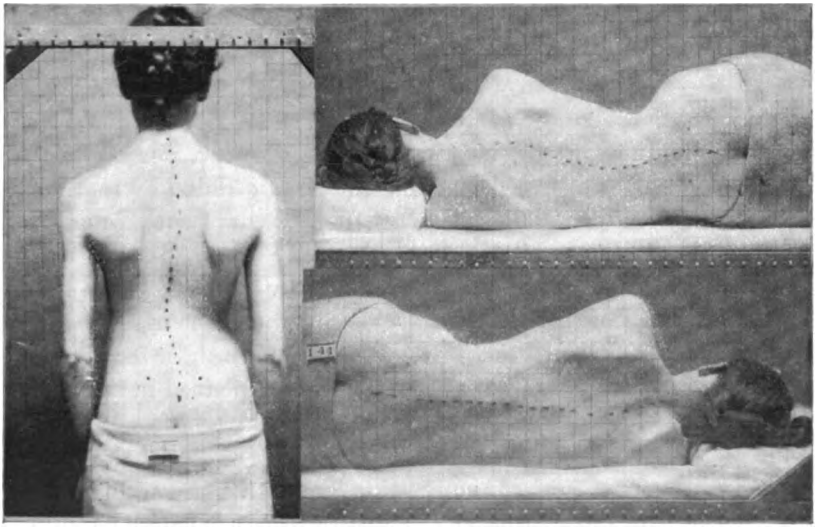
BED POSTURE AS AN ETIOLOGICAL FACTOR IN SPINAL CURVATURE.[1]

By G. W. FITZ, M.D.,
CAMBRIDGE.

THE problem of the influence of bed posture in the production of spinal curvature has attracted my attention for a number of years, and I have taken photographs of cases in which a complete history of habit of sleep upon one side was obtained. These cases



represent both side postures, and resemble one another so closely that the accompanying photographs may be considered typical. The first figure shows the curve as seen when the patient is stand-

[1] Based on studies made in the curvature clinic of the Boston Children's Hospital.

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ing; the second, when in the habitual sleeping posture; and the third, when in the reversed position.

The curves are explained by the fact that the hips and shoulders are the broadest parts of the trunk and support the ends of the spine, leaving the middle portion suspended between them. The head also, unless a pillow of sufficient thickness is used to keep it in line, tends to slope down toward the mattress and assists in their formation.

The period of sleep is one-half to one-third of the growing time of the child, and, consequently, the pressures and strains of an habitual sleeping posture have an opportunity to influence the growth of the vertebræ and ligaments and shape them in accordance with their relative positions in the curve.

The cases studied show marked rotation, and although we cannot attribute such rotation to the sleeping posture, yet it is doubtless true that any asymmetry of the vertebræ caused by unequal growth in the habitual sleeping posture will lead, in standing and sitting positions, to complex stresses upon the various bones and ligaments, and will result in increased curvature with rotation.

In the eight cases in which a complete history of habitual bed positions was obtained, the fundamental curves correspond to the curves produced in the normal individual with a flexible spine when lying upon the corresponding side, but modified by rotation. In no case with such a history have I found a curve not thoroughly consistent with this etiology.

Histories of bed postures are, however, difficult to get, since parents are usually ignorant of the sleeping positions of their children. I am convinced that if we could ascertain them for all curvature cases, a considerable number would be explained in this way. Furthermore, it is not improbable that habitual postures at school and at home are more or less determined by the shapes of the vertebræ and the lengths of the supporting ligaments, and are manifestations of attempts at easy attitudes necessitated by such faulty bones and ligaments.

Summary.

1. Lateral bed postures curve the spine.

2. Habitual lateral bed postures, by favoring the growth of the spine on one side and retarding it on the other, tend to fix such a

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curve by establishing physical changes in the bones and ligaments.

3. The time in bed is so large a part of the growing period that the distortion may become pronounced.

4. Inequality in the vertebræ and the supporting ligaments brings about asymmetrical strains in standing and sitting postures, resulting in increased curvature with rotation.

5. Bed posture thus becomes an important factor not only in the etiology of curvature but in its treatment.

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A COMMON, UNDESCRIBED AFFECTION OF THE EXTENSOR MUSCLES OF THE THUMB.

By PHIL. HOFFMANN, M.D.,
ST. LOUIS, MO.

THE condition described below I consider common in so far as, in my experience, it has occurred about one-fourth as frequently as sprain of the ankle. I can find reference to it in none of the mass of literature, both old and new, consulted by me. This, together with the facts that the symptoms, without rigid examination, are somewhat misleading, and that fully two-thirds of the cases coming under my observation had passed through the hands of other practitioners, some being examined by two or three different surgeons on separate occasions, without the diagnosis being made, leads me to believe that, as a rule, the real trouble is not recognized.

Before describing the affection itself, it will, perhaps, be well to review, in a rough way, the locations, origins, and attachments of the three muscles involved.

The *extensor ossis metacarpi pollicis* arises from the posterior surface of the middle third of the radius and posterior surface of the shaft of the ulna below its upper fourth. It passes downward and outward, terminating in a tendon which runs over the outer side of the styloid process of the radius, to be inserted into the base of the metacarpal bone of the thumb.

The *extensor primi internodii pollicis* is a small muscle lying to the inner side of the extensor ossis metacarpi pollicis, and arises from the posterior surface of the shaft of the radius just below it. It also passes downward and outward, its tendon accompanying that of the extensor ossis metacarpi across the outer side of the styloid process, to be inserted into the base of the first phalanx of the thumb.

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The *extensor secundi internodii pollicis* arises from the middle third of the posterior surface of the shaft of the ulna, and terminates in a tendon which runs over the posterior surface of the lower end of the radius, and then obliquely downward and outward, to be inserted into the base of the last phalanx of the thumb.

All three muscles are extensors of the thumb. The first acts on the metacarpal bone; the other two on the phalanges. Their tendons stand out distinctly where they cross the radial aspect of the wrist. If the thumb be held in the position of full extension, a triangular fossa, the so-called anatomical snuff-box, will be observed between them, the extensor ossis metacarpi and primi internodii forming its outer, and the secundi internodii its inner boundaries.

The bellies of these muscles are superficial in their lower parts. Their outlines are apparent to both the eye and touch in the lower third of the radial side of the dorsal aspect of the forearm. When in action their movements can be distinctly felt.

Two years ago my attention was first directed to the class of cases under discussion in the following manner: A female patient, aged forty-five years, entered the orthopedic clinic of the Missouri Medical College, complaining of pain, which had been present for almost three months, about the styloid process of the left radius. It often kept her awake at night, and at the time she consulted me she was unable to use the hand much on account of the distress it caused. She did not remember receiving any injury. Examination of the wrist-joint showed good motion and nothing wrong except considerable pain on extreme adduction of the hand and some tenderness over the lower portion of the radius which, apparently, was not seated in the bone.

Not being able to make a diagnosis, I firmly supported the wrist-joint with rubber adhesive plaster and asked the patient to call again. In three days she returned, feeling no better. I made another examination, with the same result as before. Then, experimentally, I fixed the wrist in a plaster-of-Paris dressing, leaving, as is usual, the thumb free. The dressing remained on a week without giving the slightest relief. I now suspected that I had to deal with a so-called hysterical joint, and was removing the plaster dressing when, quite accidentally, I suddenly and

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forcibly flexed her thumb. This caused intense suffering, which led to further investigation as soon as the splint was removed. I found all the joints of the thumb normal, but whenever I flexed it to the full limit, thus stretching the extensor muscles, the pain over the lower end of the radius was increased. Examination brought forth other symptoms, all pointing to involvement of the extensors of the thumb.

Since then I have seen eleven similar cases, all presenting signs and symptoms much as described below. Full passive flexion causes pain by stretching the extensor muscles and their tendons.

Voluntary extension is painful, on account of muscle contraction.

Resisted voluntary extension is especially painful, on account of the excessive muscle exertion.

Contracting the extensors and pressing upon their tense, prominent tendons where they cross the wrist causes great pain.

Sometimes there is pain on pressure over the superficial portion of the muscle bellies.

Passive extension, by relaxing the muscles and their tendons, gives relief.

A striking test is for the *surgeon* to *passively* extend the thumb, thus relaxing the muscles and causing no pain, and then to let go, asking the patient to *voluntarily* retain the thumb in the extended position. This will necessitate contraction of the muscles, as evidenced by their tendons becoming prominent, and so cause the characteristic pain.

In fact, any movement or position that stretches or produces contraction of the extensors will be painful ; while, on the contrary, one that relaxes them will give ease.

Moderate flexion, resisted voluntary flexion, and full *passive* extension cause no pain, showing that the flexors are not involved.

Extreme flexion only causes pain by stretching the extensors.

Adduction of the *hand* stretches the extensor thumb muscles and may cause pain.

Passive abduction of the *hand*, by relaxing them, relieves or at least causes no pain ; while *active* abduction brings these muscles into play and, as a rule, is painful.

Sometimes very slight swelling over the muscles or their tendons can, on careful examination, be observed ; but in fully one-half of

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my cases this was absent, and the diagnosis had to be based on an examination of muscle action as outlined above.

The length of time the pain had been in existence before I saw the patients varied from seven weeks to eight months, as shown in the following table:

In 1 case about 7 weeks.	In 1 case about 15 weeks.
In 3 cases about 2 months.	In 1 case about 4 months.
In 2 cases about 10 weeks.	In 1 case about 5 months.
In 2 cases about 3 months.	In 1 case about 8 months.

This seems to show a tendency in these cases to continue indefinitely, without proper treatment.

As to the exciting causes: One case was struck on the forearm by a piece of falling kindling wood; in another the pain came on after a fall down stairs; in another, after carrying an eight-year-old boy for ten or fifteen minutes; in another while drying dishes; and in another after a sudden wrench of the hand during a quarrel. In seven cases I could get no history of a blow, wrench, or other injury, though in three of these the occupation might have brought on the trouble. Thus, one case occurred in a kitchen-girl who used a bread-knife for four or five hours daily, which, she said, greatly tired her hand. Another was present in a woman who was accustomed to wringing clothes with her hands. The third appeared in a man, who, for eight or nine hours each day, stood catching packages which were thrown from a wagon and weighed from seven to ten pounds.

The only treatment I have resorted to is fixation. For this purpose I employed the plaster-of-Paris bandage, applying it from the tip of the thumb to near the bend of the elbow, leaving the other fingers free.

Thorough immobilization always relieved the pain; but I found that if the bandage was not tightly applied, and even slight action of the extensor muscles permitted, the pain, at times, would continue. So I found it necessary to cut open the splint and tighten it whenever it became loose.

The thumb should be put up in the extended position so as to relax the affected muscles.

As to the final outcome of the cases: Five, after treating for awhile, I lost sight of; two recovered in from six to seven weeks;

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one in two months; one in three months; two in four months; and one was under treatment for nearly six months before the support was entirely removed. In several, after the pain had entirely disappeared for two or three weeks, I removed the bandage; but it soon recurred, and I was obliged to again immobilize the thumb.

I must acknowledge that I do not understand the pathology of these cases, never having had the opportunity of cutting down upon the involved structures and examining them. I suspect their character to be that of a chronic, non-tubercular thecitis. The swelling and tenderness present over the muscles and tendons in some of the cases point that way. I have seen a number of cases of *acute* thecitis or tenosynovitis of the extensor muscles of the thumb where, in addition to all the symptoms described above, there was also present the characteristic leathery creak or grating on motion. These cases, as is usual when they occur in any other muscles, yielded readily to two or three weeks of immobilization. They were also very easy to diagnose.

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A CONTRIBUTION TO THE STUDY OF HIP-JOINT DISEASE, ON THE ULTIMATE RESULTS OF THE MECHANICAL AND OPERATIVE TREATMENT,

With an Analysis of 150 Cases Observed at the Hospital for Ruptured and Crippled.

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To the collector of statistical data it is unnecessary to offer an apology for any defects that exist or may seem to exist in tables of this character. The tracing of hospital patients is recognized as exceedingly difficult. The shifting population of a large city, and even the towns bordering upon it, makes the collection of facts a task that is not coveted by those who have had experience in this kind of work, yet it is from study of such a collection that one gets the most valuable information and is enabled to make use of the experience gained in hospitals. For several years it has been the aim to follow as closely as possible patients who have been removed or been discharged.

A system something about as follows has been adopted: An envelope is given each patient containing a card with the patient's name, diagnosis, case-book and page, also date of discharge, with instruction to return at stated times for observation, and in addition to this a circular which explains more fully the directions on the card and the hospital's willingness to send aid in case the patient is unable to attend. Even with these precautions it is hard to

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enforce any kind of discipline, so hopelessly irresponsible do some families appear.

In January, 1896, we began a systematic measurement of cases of hip-joint disease discharged from the hospital at least five years previous to this date. A study of former statistical papers enabled us to decide upon the data. The aim, therefore, has been to get at all the facts that bear upon the treatment—whether constitutional, mechanical, or operative. Measurements and observations recorded in case-books were not regarded as sufficiently recent, so it was deemed advisable to make personal examinations of the 150 patients, whose cases are herein tabulated.

The following are all the points covered: Name, age on admission to the hospital, sex, side affected, duration of disease before applying to the hospital, hospital or out-door department treatment primarily, the method of treatment before admission to the hospital, condition at first examination, whether acute or not; deformity, abscess, sinus, shortening, motion, the treatment received in the hospital, and the final result of this treatment, including the angle of deformity, whether acute or not, amount of shortening, abscess, sinus, or motion present, and the length of time which had elapsed since discharge from the hospital. It was impossible to record the exact time which the patient remained in the hospital, as many of them were admitted for short intervals, then discharged and readmitted at some later period, according to the gravity of the case and the necessity for constant observation. In taking the cases from the record-books of the hospital each one was taken in the order in which it came, provided five years or more had elapsed since discharge; otherwise case was not included. A letter was written to the patients asking them to report for final examination. Many letters were, of course, returned, great difficulty being encountered in getting the proper address. If, after writing two or three times, no reply was received, another case was substituted for this one. This procedure was necessary in order to obtain 150 cases. Where the patient had died the parents or relatives were asked the condition at the time of death, and in some instances this information was obtained from the attending physician. As a personal examination of these patients could not be made, the results of the last recorded in the hospital-books was taken.

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The inaccuracy of the statements made by the patients in regard to the treatment which they had received at other hospitals made it necessary to note only the methods used in the Out-door Department of the Ruptured and Crippled, except in instances where they were wearing plaster-of-Paris or a brace at the time when admitted to the hospital. The early management before coming under constant supervision is associated with many difficulties—more particularly in cases where apparatus is used, for the parents frequently remove it, refusing to have their child wear a brace, and thus the patient is neglected for many weeks, and even months at a time, when strict mechanical procedure should be carried out in order to guard against as little destruction of the joint as is possible. For this reason plaster-of-Paris has been found to be an admirable substitute, as the parents are not so likely to remove it, and in the compilation of these statistics the fact is emphasized that the ultimate results were far superior where this had been used in the earlier stages as a means of protection. In private cases, however, it is not necessary to use it to the same extent as in out-door hospital patients, for the former class are constantly under the supervision of the attending physician.

In employing the term cure in this connection we mean to state that the patients so designated are, to all appearances, free from disease. Treatment has been suspended after a sufficient length of time, and nothing remains as a sequel of the disease other than deformity or shortening. This will include also cases where the function has been restored. A perfect cure is so seldom found in collecting statistics that we have decided not to make use of the term in this sense. The treatment employed has varied. Prior to 1887 apparatus was not employed at the hospital. The treatment was spoken of as expectant, meaning thereby a recourse to counter-irritants, such as blisters or liniments, and rest in bed or in a wheeled chair. Leeches and the Paquelin cautery were not employed. Since the fall of 1887 the long traction-splint has been used in the majority of instances; weight and pulley on inclined plane, fixation in plaster-of-Paris, correction of deformity under an anæsthetic, with retention apparatus. The treatment, therefore, has been regarded as modern. Supplemental to correction under an anæsthetic by force, we have employed femoral osteotomy, more

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frequently subcutaneously; sometimes an excision of the joint, etc. The operative procedures, therefore, have all been such as require an anæsthetic. Sometimes the mere puncture of an abscess has not been noted on the operation-book.

To be more specific, the following are the procedures adopted: Correction by manual force, supplemented often by myotomy, tenotomy, osteotomy, excision, evacuation of abscesses by free incision, and the curettage of sinuses.

In 109 cases the patients had some form of previous treatment before they were admitted, and only 41 are recorded as having entered without apparatus or treatment prior to admission. Of the series 107 are now entirely cured and are wearing no mechanical apparatus whatsoever; indeed, are able to follow an occupation without the slightest trouble. All of them have been seen personally at the time when examination was made; 25 are wearing apparatus, but a number of these are in such a condition that they could leave the brace off without the slightest danger of a recurrence; but these have not been included in the table of cured cases. Added to these are 7 who are going about without apparatus, but who, after a thorough examination, have been advised to return to the hospital for further correction of the deformity—it being concluded that four might be benefited by femoral osteotomy and three by attempts at stretching. Eleven have died, all of whom having been discharged from the hospital at least five years. The cause and a full consideration of their clinical condition at the time will be given later. The disease occurred 71 times in males and 79 times in females, and in 80 cases the right hip was involved, in 64 the left, and both hips were affected in 5 cases. The average age at which the disease began was between five and seven years. The youngest child when brought for advice was two months old, while the oldest was nineteen years. In five instances the disease was complicated with Pott's disease of the spine; in two it preceded the joint trouble, in three it was secondary to it. In but comparatively few could a definite family history be obtained, for only in 29 of the entire series was the parents' statement in this record given recognition, and it was found that the father was tuberculous in 14, the mother in 11, and the brothers and sisters in 4.

A glance at the table will give one an idea of the disposition of the 150 cases:

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TABLE I.

Cured	107
Still under treatment	25
Advised re-admission for correction of deformity	7
Deaths	11
Total	150

TABLE II.—CASES ADVISED RE-ADMISSION FOR THE CORRECTION OF DEFORMITY.

No.	Final result (angle greatest extension).	Shortening.	Present condition.	Length of time since discharged from hospital.
1	140°	1 inch.	Good motion.	6 years.
2	145	2 inches.	Walks poorly.	10 "
3	155	None.	Limited motion.	17½ "
4	140	3 inches.	Hip anchylosed.	5½ "
5	165	1 inch.	" "	8 "
6	150	1½ inch.	Limited motion.	6¼ "
7	150	None.	Good motion.	7½ "

Most of the cases in Table II. were either in the hospital at the time when very few operations were performed, or have been neglected through the parents refusing to bring them at stated intervals for examination or by removing the braces and discontinuing the treatment without permission. All are now free from abscesses and sinuses, and none of them are acute, and in view of their deformity, every indication is present for some procedure which will correct it.

Of the 107 cases regarded as cured, 89 were acute at the time of the first examination. By the term acute is meant an acute exacerbation. It may be that the acuteness of the exacerbation has nothing to do with the stage of the disease. The 89, therefore, which were so designated, were not necessarily in the first stage. Indeed, it is seldom that a patient is admitted to the hospital in the first stage. Most of the cases are already well advanced in the disease, and may be getting on comfortably when a slight trauma serves to induce an exacerbation, and for this they come into the hospital. Of the 25 cases still under treatment, 19 were in one of these exacerbations when they first came under observation. All surgeons have long since recognized different grades of the disease. We all know that some cases are more severely attacked at the outset, and that two or more foci may be lighted up simultaneously. We mention this, not by way of apology for the twenty-five that are still under observation, but merely to explain some of these obstinate forms of the disease.

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TABLE III.—RELATION OF ABSCESS TO SHORTENING AT FIRST EXAMINATION IN 150 CASES

Shortening in inches.	Abscesses.	Cases without abscesses.	Shortening in inches.	Abscesses.	Cases without abscesses.
None	13	33	3 1/4	0	1
1/8 to 1/4	5	7	3 1/2	0	3
1/2	6	11	3 3/4	3	0
3/4	4	5	4	1	0
1	2	8	4 1/4	0	0
1 1/8 to 1/4	3	3	4 1/2	2	2
1 1/2	4	7	4 3/4	0	0
1 3/4	1	1	5	0	0
2	3	4	5 1/2	0	0
2 1/8 to 1/4	0	6	6	1	0
2 1/2	1	3	6 1/2	0	0
2 3/4	0	1			
3	2	4	Total	51	99

It will be seen by referring to Table III. that 51 of the 150 or at least one-third had abscesses at the time hospital treatment was begun. By referring to the column marked "Shortening" one can see what relationship abscess bears to the different stages. For example, a suppuration may begin, and, indeed, did begin in thirteen instances where there was no shortening and where the disease was presumably in the first stage. Indeed, it would seem that an abscess is still more common in the early stage and that a case once having reached the third stage of the disease is not apt to develop abscess. It is not deemed of sufficient interest to designate the number of sinuses which appeared. Suffice it to say that the popular impression is not far from correct that when an abscess once forms, others may be expected. This is abundantly borne out by statistics.

TABLE IV.—ANGLES OF GREATEST EXTENSION.

In Cured Cases.

At first observation.		*Final examination.*	
Angles (in degrees).	No. of cases.	Angles (in degrees).	No. of cases.
90 to 100	2	90 to 100	0
100 " 110	5	100 " 110	0
110 " 120	5	110 " 120	0
120 " 130	5	120 " 130	0
130 " 140	21	130 " 140	0
140 " 150	19	140 " 150	0
150 " 160	12	150 " 160	10
160 " 170	27	160 " 170	20
170 " 180	3	170 " 180	30
180	8	180	47
Total	107	Total	107

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In Cases Still Under Treatment.

First examination.		*Final examination.*	
Angles (in degrees).	No. of cases.	Angles (in degrees).	No. of cases.
90 to 100	3	90 to 100	0
100 " 110	3	100 " 110	0
110 " 120	2	110 " 120	0
120 " 130	3	120 " 130	0
130 " 140	2	130 " 140	3
140 " 150	2	140 " 150	5
150 " 160	3	150 " 160	5
160 " 170	0	160 " 170	5
170 " 180	5	170 " 180	5
180	2	180	2
Total	25		25

Table IV. shows that the great majority first coming under treatment already present a degree of deformity. In 22 instances there was an angle of 160°, and as it is difficult for two or three observers to measure with the same degree of accuracy, it may be safely assumed that 39 were in the neighborhood of 160°. A very common deformity is 140°, and it is astonishing how well a child can walk with an angle of extension of 140°. It is sometimes a question where this angle of extension seems to be pronounced, and where a small sinus or two complicaties, whether it is not best to refrain from any attempts at correction by force. It would have been interesting to have noted the degree of adduction combined with flexion, but the angle of adduction in many cases was omitted. The practical bearing of this combination is the important question, whether attempt at correction is or is not necessary. Where adduction is a very prominent feature with very little flexion, then correction should be attempted. This is a good rule to follow, especially in the female sex. At the hospital it is usually regarded as important to admit patients who have even a moderate degree of adduction combined with flexion. We feel that the results are worthy of note. Only six of the 107 cases present a deformity greater than 150°, and it is satisfactory to note that 47 present no deformity whatever. Indeed, 30 might be added to this, which would give us 77, or more than half, where the deformity was scarcely appreciable, inasmuch as 170° is not regarded as of any moment in estimating the usefulness of a limb. Of the cases still under treatment, the deformity has been corrected in nearly all. A few (five or six) present a deformity ranging between 135° and

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150°. There are a certain number that have been advised re-admission to the hospital, and, as above stated, all of these present a degree of adduction which makes this necessary.

TABLE V.—SHORTENING IN INCHES.

In Cured Cases.

At first observation.		*At final examination.*	
Inches.	No. of cases.	Inches.	No. of cases.
None	85	None	21
1/4	11	1/4	7
1/2	12	1/2	12
3/4	5	3/4	7
1	6	1	24
1 1/8	1	1 1/8	4
1 1/4	4	1 1/4	6
1 1/2	7	1 1/2	3
1 3/4	2	1 3/4	2
2	4	2	7
2 1/8	2	2 1/8	3
2 1/4	3	2 1/4	2
2 1/2	3	2 1/2	2
2 3/4	1	2 3/4	1
3	4	3	1
3 1/4	1	3 1/4	0
3 1/2	2	3 1/2	3
3 3/4	1	3 3/4	0
4	1	4	1
4 1/4	2	4 1/4	0
		6	1
Total	107	Total	107

In Cases Still Under Treatment.

First observation.		*Final examination.*	
Inches.	No. of cases.	Inches.	No. of cases.
None	4	None	2
1/4	1	1/4	0
1/2	2	1/2	0
3/4	2	3/4	1
1	2	1	2
1 1/8	0	1 1/8	1
1 1/4	0	1 1/4	1
1 1/2	2	1 1/2	2
1 3/4	0	1 3/4	3
2	2	2	2
2 1/8	0	2 1/8	1
2 1/4	1	2 1/4	0
2 1/2	1	2 1/2	1
2 3/4	0	2 3/4	0
3	2	3	2
3 1/4	0	3 1/4	3
3 1/2	1	3 1/2	0
3 3/4	2	3 1/4	2
4	0	4	0
4 1/2	2	4 1/4	1
6	1	6 1/2	1
Total	25	Total	25

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In Cases Advised Re-admission for the Correction of Deformity.

First observation.		*First observation.*	
Inches.	No. of cases.	Inches.	No. of cases.
None	3	2¼	0
¼	0	2½	0
½	1	2¾	0
¾	1	3	0
1	0	3¼	0
1⅛	0	3½	0
1¼	0	3¾	0
1½	2	4	0
1¾	0	4½	0
2	0		—
2⅛	0	Total	7

For *final examination* see Table II.

Deaths.

First observation. See Table X.

Final examination. See Table X.

TABLE VI.—AVERAGE SHORTENING (IN INCHES).

In cured cases at first observation	6/16 of an inch.
" " at final examination	5/16 " "
In cases still under treatment, first observation	1¼ inches.
" " " final examination	1⅜ "
In cases advised re-admission, first observation	⅜ of an inch.
" " " final examination	1²/₅ inches.

It will be seen from Table V. that 35 present no shortening whatever, and these were presumably in the first stage. The greatest amount of shortening was four and one-half inches, and the average was one inch. At the final examination there were 21 who went through the disease without any shortening. This, we think, is at least satisfactory. In one case there was a shortening of six inches. The average shortening when the cases were first seen, as well as when the cure was complete, is shown in Table VI. It is of the utmost importance to discriminate between real and apparent shortening; the former is due to a retardation in the growth of the affected limb or from destruction of bone in the joint, and is independent of the amount of adduction or abduction, while the latter term may be applied to the inequality of the limbs which results from the tilting of the pelvis.

In thirty-four of the cured cases the atrophy was a marked feature. This wasting of the limb, of course, is looked upon with favor in the early management of the disease, for the reason that one is better assured that the joint is satisfactorily protected if the

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reflex spasm is abolished and if the muscles are small and attenuated. Then there is not so much need for traction. After all the atrophy is a sign of the severity of the disease. We regard a serious involvement of the head and neck as a necessary cause of atrophy. It is true, in many instances, that the muscles increase in size after the subsidence of the disease, yet this rule is not absolute. Efforts at restoring muscles by massage, electricity, and exercises are usually unsatisfactory. The best way to restore muscles to anything approaching their former size is by use of the limb.

In eleven cases we regret to note a recurvation of the knee. This ought to be prevented by the proper use of the apparatus. It is accounted for, however, in our cases, by failure of the parents to report, by their lack of interest in the apparatus, and by change of physician. The parents sometimes feel that they can have the case treated by the family physician, or they themselves apply the adhesive plasters below the knee. Sometimes excoriations occur on the thigh, and one fears a recurrence of this condition, so that the thigh is not included in the adhesive plaster for traction. Under close observation this deformity can be prevented. It is a useful lesson, however, and we wish to emphasize it in passing. The rule should be never to make traction below the knee. The common device of putting a clove-hitch about the ankle and hanging a weight over the foot of the bed is to be deprecated, because the employment of all force of this nature weakens the ligaments at the knee and gives a lax joint, which ends in recurvation or some other, similar deformity.

TABLE VII.—THE ULTIMATE RESULTS OF MOTION IN CURED CASES.

Perfect motion	13
Good motion	22
Limited motion	41
Anchylosis	31
Total	107

Our tables present, as will be seen, 13 cases with perfect motion. Adding this 13 to the 22 with good motion, there are 35 of 107 that got well with a very fair range of motion. Only 31 of the number were without motion. The term "good motion" is employed to cover the variations in measurement. Different members of the staff from time to time recorded the ranges of motion, and, while

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there may have been differences of a few degrees, it was thought best not to specify the exact range.

A small range of motion is often highly satisfactory to the patient. It brings less strain upon the spinal column and enables him to sit more comfortably in a chair and present altogether a better appearance in society.

TABLE VIII.—TREATMENT: MECHANICAL AND OPERATIVE.

In Cases Cured.

Method employed.	No. of times.
Stretching and splint	17
Plaster-of-Paris and splint	14
Braces	12
Aspiration, curetting, and splint	9
Stretching, tenotomy, subtrochanteric osteotomy, and splint	9
Stretching, tenotomy, subtrochanteric osteotomy, and splint	7
Aspiration and splint	6
Excision and splint	4
Tenotomy, plaster-of-Paris, and splint	4
Blisters	4
Blisters and splint	4
Aspiration, stretching, and splint	4
Curetting, stretching, osteotomy, and splint	3
Curetting and splint	3
Curetting, tenotomy, and splint	2
Stretching, tenotomy, and splint	2
Stretching, curetting, and splint	1
Aspiration, iodine, and splint	1
Pulley and plaster-of-Paris	1
Total	107

In Cases Still Under Treatment.

Stretching and splint	8
Splint	4
Excision of abscess and splint	3
Blisters and splint	3
Poultices and splint	1
Stretching, subtrochanteric osteotomy, and splint	1
Stretching, curetting, and splint	2
Aspiration, excision of abscess, and splint	2
Aspiration, curetting, and splint	1
Total	25

In Cases Advised to Return for Correction of Deformity.

Stretching and splint	2
Brace	1
Osteotomy and splint	1
Poultices and blisters	1
Stretching, curetting, and splint	1
Plaster-of-Paris and splint	1
Total	7

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Deaths.

Aspiration, curetting, and splint	4
Excision and splint	2
Aspiration, plaster-of-Paris, and splint	2
Stretching and splint	2
Excision of abscess, curetting, and splint	1
Total	11

TABLE IX.—FEMORAL OSTEOTOMY.

No. of case.	Duration of disease before operation.	Angle of deformity before operation.	Shortening before operation.	Angle of deformity after operation.	Shortening after operation.	Time elapsed from operation until final measurement.	Remarks.
			Inches.		Inches.		
1	3 yrs. 9 mo.	145°	2	180°	1	6 yrs. 2 mo.	Hip anchylosed.
2	4 years.	100	2	140	1⅛	7⅓ years.	" "
3	3 yrs. 1 mo.	145	1½	170	1	5 yrs. 8 mo.	Slight adduction.
4	3 years.	130	None	160	None	7 years.	5° motion.
5	5 "	155	⅛	180	1	5 "	Hip anchylosed.
6	3½ "	150	¾	160	None	5½ "	" "
7	5 "	145	3	150	2½	5 yrs. 3 mo.	Uses cane.
8	5 "	140	1	145	¼	5 years.	Uses crutch.
9	6 "	150	2	140	1	6 "	Marked limp.
10	5 "	145	1⅜	150	2	8 "	" "
11	3½ "	120	1¾	140	2	5 "	" "
12	10 "	140	6	165	2¾	5½ "	No motion.
13	6 "	140	1	180	None	6 "	" "
14	10 "	130	1¼	170	1	5 "	" "
15	10 "	110	1⅜	180	None	6½ "	" "
16	2 "	90	⅝	165	1	10 "	" "
17	2 "	140	¼	150	⅛	7 "	Very little motion.
18	12 "	90	4¼	175	4	6 "	No motion.
19	5 "	145	1	175	¾	5½ "	" "
20	1½ "	130	None	170	None	8 "	Some adduction.
21	1 year.	135	2	150	2	6 "	At times wears brace.

Amount of Shortening.

Before operation.		*After operation.*	
None	2	None	5
¼	1	¼	2
½	1	¾	1
¾	2	1	6
1	3	1⅛	1
1¼	2	2	3
1¾	3	2⅛	1
2	4	2¼	1
3	1	4	1
4¼	1		
6	1		
Total	21	Total	21

Angle of Deformity.

Before operation.		*After operation.*	
90° to 100°	2	90° to 100°	0
100 " 110	1	100 " 110	0
110 " 120	1	110 " 120	0
120 " 130	1	120 " 130	0
130 " 140	4	130 " 140	0
140 " 150	9	140 " 150	4
150 " 160	3	150 " 160	3
160 " 170	0	160 " 170	4
170 " 180	0	170 " 180	10
Total	21	Total	21

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Table IX. shows the osteotomies and explains itself. The osteotomies are always supplemented by apparatus for a variable length of time—from a few weeks to a few months. It has been a matter of common observation that even a bone, long after a union has taken place, will sometimes bend again, or at least the tissues about the hip will be contracted and give rise to a deformity which needs further correction.

It will be seen that twenty-one patients were submitted to this operation. This means that other methods failed to correct the deformity. We have been quite persistent in our efforts to correct by traction in bed with weight and pulley on incline plane, and time and again we have submitted patients to tenotomy, myotomy, and forcible stretching. Where all these fail then we resort to femoral osteotomy.

TABLE X.—DEATHS.

Condition at First Observation.

No.	Acute.	Deformity.	Abscess.	Sinus.	Shortening.	Motion.
1	Yes	135°	Yes	Yes	No	No
2	"	R. 120	"	"	"	"
3	"	L. 110	"	"	1 inch	"
4	"	180	"	"	1 "	Yes
5	"	170	No	No	No	No
6	No	R. 120 / L. 130	"	"	2 inches	Yes
7	Yes	115	Yes	Yes	¾ inch	"
8	"	160	No	No	½ "	No
9	"	None	"	"	⅓ No	"
10	"	150°	"	Yes	"	"
11	"	110	"	"	¼ inch	"

Condition at Final Examination.

No.	Acute.	Deformity.	Shortening.	Abscess.	Sinus.	Cause of death.
1	Yes	170°	None	Yes	Yes	Amyloid degeneration.
2	"	R. 130 / L. 145	L. 1 inch.	"	"	" "
3	"	160	1 "	No	"	" "
4	No	160	3 inches.	"	"	" "
5	"	165	1 inch.	Yes	"	" "
6	Yes	R. 140 / L. 150	2 inches.	"	"	Phthisis pulmonalis
7	No	175	1 inch.	No	No	" "
8	Yes	160	None.	"	"	" "
9	"	150	"	"	Yes	Tuberculous meningitis.
10	No	165	"	"	"	" "
11	"	180	"	"	No	Cardiac disease.

Our experience leads us to dwell upon the necessity for maintenance of the good position gained by an osteotomy during a period

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of from six to twelve months. In cases where this precaution is not taken, relapses do occur. Whether they occur because the disease is not fully arrested we cannot say. The test of cure in an old case does not apply frequently, and we must be governed by the duration of the disease, by the condition of the patient, and by the long absence of pain. The osteotomy, therefore, is to be followed by the maintenance of a good position —whether one resorts to apparatus, plaster-of-Paris, or traction in bed.

Of the cases that died, eleven in number, both joints were affected in two instances, and one of these had an abscess and sinus at the first examination, while the other did not. However, both developed this state during the course of the disease, both hips being involved and the suppurative condition remaining until the time of death, although it was noticeably greater in the one that died from amyloid degeneration than in the other, who developed secondary infection of the lungs. In the other four cases where death was due to long-continued suppuration, all except one had an abscess and sinus when first seen, but latterly only two had abscesses, while four still had sinuses. All were very acute on admission, and three were found to be so at the final examination. In these same cases the angle of greatest extension in one was 170° at the time of death, in one 165°, in two 160°, and in one 130° on the right side and 145° on the left. One had no shortening, three one inch, and one three inches shortening. One case lived twelve years after the onset of the disease, two between six and six and a half years, one eight years, and one seven years. Where the cause of death was due to phthisis pulmonalis, as it was in three cases, two were acute at the first examination, only one had an abscess and sinus, and one no motion or shortening, and a difference in the comparative lengths of the legs of two inches in one and three-quarters of an inch in the other, while the angle of greatest extension of one was 160°, the other 115°, and where it occurred on both sides the right was 120° and the left 130°. On final examination in each case less than a year before death, it is remarked that two were acute, one had one inch shortening, the other two inches, and in the third there was no difference. Two had abscesses at the time of death, while all three had sinuses, and the

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angles of greatest extension were 160°, 170°, and in one case where it occurred on both sides, the right was 140° and the left 150°. Two cases lived five years and one seven years before developing pulmonary disease. In one of this series the predisposition to affection of the lungs might have been anticipated, for both the father and mother died of the same affection shortly before their child. Tuberculous meningitis claimed two cases, neither having shortening, motion, or abscess when first examined, but were markedly acute. One had a sinus and one no deformity, while the other had an angle of greatest extension of 150°. At the final examination one was still very acute and had one inch shortening, while both had sinuses and motion, but no abscesses, and the angles of greatest extension were 150° and 165° respectively. The meningitis did not manifest itself until the joint disease had extended over five years in one instance and six years in the other. One case with incurable disease of the heart was doing very well, although the brace had not been removed because the joint was still in an acute condition at the time of death, so it was included in the deaths. A letter received from the attending physician stated the cause to be mitral and aortic stenosis. One patient who had amyloid disease, lingering between life and death for a year, became equally discouraged with its parents in seeing no improvement, and all three committed suicide.

Death did not appear to be dependent upon operative procedures, for only in two cases of the series was a radical operation performed, and the patient did not die until five years later, in the mean time developing many abscesses.

TABLE XI.—AVERAGE. ON A BASIS OF 150 CASES.

	Percentages.
Males	47
Females	52
Right side	53
Left side	43
Both sides	3
Had some treatment before admission to hospital	72
Had no " " " " "	27
Entirely cured	71
Still under treatment	16
Correction of deformity advised	4
Deaths	7
Subtrochanteric osteotomy	14

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Cured Cases (107).

	Percentages.
Acute at first observation	88
Abscess at first observation	37
Sinus at " "	19
Had some angular deformity at first observation	92
" no shortening at first observation	32
" some motion at " "	82
" no deformity at final examination	44
" no shortening at " "	19
" perfect motion at " "	12
" good " " "	20
" limited " " "	37
" anchylosis at final examination	29

Cases Still Under Treatment (25).

	Percentages.
Acute at first observation	76
Abscess at first observation	44
Sinus at " "	8
Had some angular deformity at first observation	92
" no shortening at first observation	16
" some motion at " "	84
" no deformity at final examination	8
" no shortening at " "	8
" perfect motion at " "	4
" good " " "	24
" limited " " "	56
" anchylosis at final examination	16

TABLE XII.—SHOWING TIME ELAPSED SINCE CASES LEFT HOSPITAL.

Cured Cases (107).

Years,	5-7	7-9	9-11	11-13	13-15	15-17	17-19	20	
No. of cases,	42	26	20	8	6	8	1	1	Total, 107

Still Under Treatment (25)

Years,	5-7	7-9	9-11	11-13	13-15	15-17	17-19	20	
No. of cases,	14	5	3	2	0	1	0	0	Total, 25

Same in cases advised re-admission (see Table II.).
Deaths (see Table X.).

The following deductions may be made:

1. Hygienic and constitutional measures exert a powerful influence in the control of the disease.

2. The early diagnosis of hip-joint disease represents a very important factor in attaining a successful ultimate result.

3. During the acute stage rest in bed associated with the usual mechanical appliances is preferable to ambulatory treatment.

4. In the first stage it is essential to procure absolute immobilization by fixation and traction (extension), and also to furnish protection to the joint.

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5. In the second stage the deformity must be corrected, and operative procedures resorted to if mechanical methods fail after a reasonable length of time—usually six months.

6. Early correction of the deformity is advised, using as little force as is consistent with the individual case.

7. Adduction with flexion is the deformity which most frequently calls for correction.

8. Flexion without adduction rarely requires correction.

9. Manual force, followed by fixation, should be tried before attempting reposition by femoral osteotomy.

10. Where there is absolute anchylosis or only a few degrees of motion, and all manifestations incident to an acute condition have subsided, the operation of subtrochanteric osteotomy for the correction of the deformity is indicated, supplemented if necessary by tenotomy, myotomy, and fasciotomy.

11. The injection of various chemical substances into abscesses and sinuses has not proved beneficial.

12. When an abscess does not disappear after repeated aspiration, radical operative procedures tending toward its removal are clearly indicated, to be followed, if necessary, by resection of the joint.

13. When the disease is complicated by pus formation in young children, more especially in the first years of life, there is less need of fearing a poor result than in adults, as the former frequently recover with a movable joint, a condition which may be explained by the fact that the head of the bone at this time is cartilaginous.

14. Long-standing and profuse suppuration retard the process of reparation and give rise to a grave prognosis; furthermore, the absorption of pus is associated with great danger, and frequently results in acute septicæmia or amyloid degeneration.

15. Treatment should be continued not only during the acute and subacute stages, but also during the convalescent period.

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LOCAL MUSCULAR WEAKNESS AS A CAUSE OF JOINT IRRITATION.

By ROBERT W. LOVETT, M.D.,
BOSTON.

In formulating what must be common experience to you all I am anxious to insist upon a factor which has not yet found its way into literature to any extent, and which seems to me to play an important part in joint affections, especially in the late history of joint injuries and inflammations.

Joints must depend for their proper mechanical use not only upon the well-being of cartilage, synovial membrane, and ligaments, but also upon the tone and strength of the muscles controlling them. Strong muscles protect joints and render them less vulnerable; weak muscles deprive the joints of their normal support, increase the liability to injury, and throw an undue proportion of work upon the ligaments and joint structures. I beg your consideration of some cases illustrating these points.

Case I. *A case of synovitis apparently due to muscular weakness.*—A healthy young girl, sixteen years old, was referred to me in November, 1897, by Dr. W. L. Richardson. Six years ago she had wrenched her right knee in crossing the ocean, and the knee was sore after it for a long time. She could walk upon it and was never confined to bed. It got better, although it did not entirely recover, and a year later she wrenched it again. Three years ago she sprained it so badly that she was in bed with it; slight sprains have been occurring ever since and have become more frequent during the last year. Two years ago she sprained the other knee and has had some slight sprains on that side, which have also increased in frequency, but the right knee continued the worst and was more frequently injured. For the last few months pain has

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been present in both knees most of the time, but this pain has never been severe enough to suggest a dislocation of the patella or of the semilunar cartilages. It was aggravated by standing or walking, and the patient was unable to walk one-half a mile without severe pain. There is no rheumatism in the family and no personal history of any.

The girl was well developed, tall, but slender; she walked with an unsteady, swaying gait, evidently due to imperfect flexion of the knees. There was no flat-foot or marked pronation of the foot; motion was perfect, and there was no grating; the patella reflexes were normal, and there were no symptoms of any organic nervous disease. On examination the small size of the thighs was the striking feature; the calves were better by comparison, but were poorly developed. There was a moderate effusion in the right knee-joint, with some thickening of the synovial membrane and a little tenderness. There was a slight effusion in the left knee-joint. It was obviously, for these reasons, not a purely hysterical affection, and I made the diagnosis of double synovitis due to constant traumatisms of the joints on account of imperfect muscular support. As the knee-joints when seen were obviously in a condition of subacute inflammation, it seemed to me that fixation was first needed to cure this irritation; the treatment, therefore, consisted of fixation by a ham-splint with compression to the right knee-joint to prevent motion and cause the absorption of the fluid. Little or no walking was permitted, and douching with hot and cold water was begun in a few days; daily massage was commenced in about a week. In three weeks the effusion had disappeared in the worst knee and motion was gradually allowed by removing the splint for an increasing time each day. The muscles improved rapidly in firmness and size, and the pain disappeared.

In April, 1898, the patient reported that she had been apparently well for some weeks. She had no pain in the knees, the muscles are firm and of average size; she can walk several miles without discomfort, and the contour of the legs has wholly changed.

Whether the muscular disability was due originally to sprains or was the cause of them cannot be definitely determined. The history of the case led me to suspect that the muscular disability was primary, permitting the various sprains rather than resulting from

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them; certainly in November, when she came under my care, the muscular disability was quite enough to be the cause of her symptoms.

CASE II. A healthy young man, twenty-one years old, well developed, but decidedly neurotic, fell in January, 1897, while skating, and struck both knees; they were lame for some time, but apparently recovered. In April, 1897, his left knee began to be painful. May 17, 1897, he wrenched his left knee while playing ball by swinging the bat forcibly while his knee was bent. I saw him eight days later; he had had no treatment previous to seeing me beyond wearing an elastic knee-cap. He limped badly and suffered much discomfort. At that time there were slight synovial effusion and tenderness over the patella tendon; there was also some bulging at the sides of the patella tendon. He could not fully extend the leg by active effort when sitting without extreme pain when a certain point was reached, although passively it was not painful. The atrophy of the left thigh was very marked, especially over the vastus internus. I made the diagnosis of slight synovitis of the knee-joint with probable bursitis of the deep pretibial bursa.

A heavy flannel bandage was applied, the knee improved, and later massage three times a week was given. In June he went to his home in a Western city nearly well, and was placed under the care of a surgeon there. He did well there, but a slight sprain brought back the symptoms in the left knee. In September, 1897, eight months after the original injury, he came to Boston to be again under my care. There was no longer synovial effusion, but much pain in active extension of the leg when a certain point was reached. There were no signs of present inflammation in the knee or bursa. After a short period of fixation, frequent massage to the leg was begun on the supposition that the muscular weakness was at least a very large factor in the disability. At this time he was conscious of numberless slight sprains to the joint, the result of unguarded motions. Gradually the daily accidents which caused pain diminished and he could actively straighten the leg without much discomfort. Active exercises with weight and pulley were begun to develop the extensors and adductors of the thigh, and just as the muscles developed the pain diminished; he is now practically

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well, and the leg is nearly as large as the other. The muscles are firm, but there is still slight grating at the joint. He can walk, ride a bicycle, skate, and ride horseback without discomfort.

Here the condition seemed to be a muscular weakness the outcome of an accident outlasting the inflammation by many months and yielding only to measures directed to the development of the muscles.

CASE III. A boy, fourteen years old, of poor general muscular development, was brought to me in October, 1897, for disability in the left knee, which caused a limp. He had always had a click in the knee in full extension, but three years ago he had wrenched the knee, and it had been the source of pain and discomfort ever since. There had been no serious sprain at any time. On inspection the atrophy of the left thigh was very noticeable, the muscles were flabby and an inch less in circumference than those on the other side; the calf muscles, however, were the same on both sides. There was some synovial effusion, with slight thickening of the synovial membrane, but no marked heat or tenderness.

When the boy extended his leg, just before full extension was reached, a click was felt, and the tibia was felt to rotate outward with a jump. This click was painful. An x-ray photograph showed no abnormality. The click seemed to be an exaggeration of the normal outward rotation which should occur as the joint locks in full extension. It seemed to me that the muscular weakness might be a factor in exaggerating this, although the click was so marked that some congenital anomaly, probably in the semilunar cartilages, must have existed independently of any muscular weakness. The situation was explained to the parents, who proved willing to act on the supposition that muscular weakness was the chief cause of pain and discomfort. The leg was first fixed and the synovitis cured, and then massage and exercise given three times a week. The muscles are now nearly alike on both sides; all pain and discomfort have been absent for three months. The click is still present to a slight degree, but is not painful, and seems only a very small part of what it was originally. Here was a joint, apparently imperfect from the beginning, kept in a state of irritation by muscular weakness, and the congenital disability, which with proper

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muscular support is not a source of trouble, became a troublesome and painful factor when the muscles were weak.

Here, then, were three cases which suggest the relation of muscular weakness to joint pain as in some instances that of cause and effect. They all show some points in common, a slight injury followed by complete or partial recovery, a certain symptom recurring after other slight injuries or spontaneously, and then a gradual increase of these up to a point where surgical advice becomes necessary.

The histories of all these cases are long, they stretch over months, and the progress is discouraging to every one concerned.

That muscular atrophy occurs at once in connection with all joint inflammation is well established.[1] It seems from the history of the cases as if the inflammation may get well or nearly well, and leave the muscular atrophy. Later the poorly supported joint may become injured again and again as the result of trifling accidents, or the continued lack of proper support, without the intervention of accidents, may cause the recurrence of joint irritability of a more or less severe type. Consequently, in a joint which is the source of trouble months after the accident when there are no signs of extensive chronic joint disease, an investigation of the muscular condition becomes of value. If there is primary chronic joint disease or inflammation the muscles will, of course, be atrophied; but it must be borne in mind that what resembles chronic joint inflammation very closely may apparently result from muscular atrophy as well. This calls attention to the importance of limiting, so far as lies in the surgeon's power, the muscular weakness which occurs necessarily in connection with joint inflammations. If this is not done the muscular weakness alone may become a source of joint irritability. It enforces the importance of determining when the joint inflammation proper has ended, in order to begin upon massage and strengthening exercises. Fixation and bandaging continued beyond the time of necessity thus become not only unnecessary but harmful, in that they promote and prolong local muscular weakness from disuse. At the same time imperfect

[1] Valtat. L'atrophie musculaire dans les mal. artic. Paris.

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treatment which fails to control the inflamed joint and to quiet the inflammation promotes muscular atrophy by aggravating the joint inflammation. If any joint injury is severe enough to require fixation, this fixation should be complete enough to be efficient while it lasts, and should be discontinued as soon as the inflammation is over. If the joint injury is not severe enough to require fixation massage should find an early place in the treatment. In joint injuries half-way measures have very little to commend them and are responsible for many cases of local muscular atrophy lasting indefinitely.

I have purposely left out the consideration of neurasthenic joints and joints affected by chronic rheumatic arthritis in this connection. It seemed simpler to consider first simple inflammatory cases as demonstrating the relation of muscular atrophy to joint irritation. But I am sure that in these cases the relation is of even greater importance than in such cases as I have described.

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SUBTROCHANTERIC OSTEOTOMY FOR THE CORRECTION OF DEFORMITIES RESULTING FROM HIP DISEASE; REPORT OF CASES.

By JOEL E. GOLDTHWAIT, M.D.,
BOSTON.

AND

C. F. PAINTER, M.D.,
BOSTON.

The following cases are reported in order to put on record a series of ten consecutive osteotomies of the femur performed in adults for the correction of the deformities resulting from hip disease, and also to call attention to certain conditions which have resulted from these deformities and which have been strikingly relieved by the operation. The cases are of interest partly because of the degree of the deformity which existed and the immediate results of the operation; also, because of the effect which these deformities have upon the general health and in producing symptoms in other parts of the body. The relief of such symptoms and the immediate improvement in the general condition have been most striking, while the improvement in the mental condition, partly due to this and partly due to correction of the unsightly deformity, has been equally gratifying.

In all ten cases are reported. Of these eight were men and two were women. All were of an age and position in which self-support was necessary, and in each instance it was because of this, directly or indirectly, that treatment was sought, either from the awkwardness or unsightliness of the deformity, or because of pain or symptoms due to strain upon other parts of the body.

Case I. X., male, twenty-six years of age, clerk by occupation. He had hip disease when two years of age, which resulted in the present deformity. Treatment was sought because of pain

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in the back, due to the muscular strain attendant upon the following deformity: Right thigh flexed to 45 degrees, adducted 35 degrees, with extreme atrophy. There were three inches of actual shortening and eight inches practical shortening. The hip was firmly anchylosed. The operation was performed in January, 1896, and the patient was kept in bed for seven weeks with weight and pulley extension and with the leg both flexed and abducted 15 degrees. At the end of the seven weeks all apparatus was removed and the patient allowed to move about in bed for another week, at the end of which time he was up, returning to work three months after the operation.

Result. He now stands erect with one inch practical shortening. His spine is now straight; he has had no pain in his back since the operation; has added two inches to his height and twenty-eight pounds to his weight. There is, of course, no motion in the joint. He is at work all the time and on his feet a great deal, and has been able to indulge in mountain climbing the past summer, and goes up and down stairs readily. Since the operation he has not lost a day from work, whereas before that for a number of years he had lost on the average three months in each year because of the pain in his back, undoubtedly due to muscular strain. Before the operation he could get around with the aid of a crutch or two canes, and he is now able to go without either.

CASE II. Mr. W., thirty-one years of age, a drug clerk by occupation, had hip disease since childhood, from which he had recovered with a flexion and adduction deformity, for which he had an osteotomy performed twelve years ago. This left him at the time of his second operation, in April, 1896, with flexion and abduction both of 45 degrees. He sought relief for pain in his back and difficulty in walking. There were seven or eight inches of practical shortening and the hip was anchylosed. After the operation he was in bed with traction and a long outside T-splint for seven and one-half weeks and one week after the removal of the apparatus.

Result. He has now 15 degrees of flexion and 10 degrees of abduction, with three-quarters of an inch real and one-quarter of an inch apparent shortening. The hip is, of course, still anchy-

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losed, but he is at work without pain and is on his feet most of the time. Before the operation he went about with the aid of two canes, while at present no support whatever is necessary.

CASE III. Mary D., eighteen years of age, had hip disease when five years old. She was a domestic by occupation. When first seen there were several old healed sinuses about the right hip, in which there was no motion and which was flexed 60 degrees and adducted 25 degrees, with one and one-quarter inch actual and four inches apparent shortening of the leg. She was operated upon January 31, 1896, and the leg put up with 15 degrees of flexion. The bed treatment was continued for seven weeks.

Result. There is real shortening of three and three-quarters inches with apparent shortening of one and one-half inches. She walks very well and can sit down easily. At the time of operation, after the chisel was removed in the manipulation, the anchylosis at the hip was broken up, and as a result there now remain about 60 degrees of motion in the joint.

CASE IV. This patient (B. F.) was a girl, fifteen years of age, whose hip disease was active in childhood. Her deformity consisted of two and one-half inches real and five and one-quarter inches apparent shortening. The hip was anchylosed and flexed to 50 degrees, adducted to 20 degrees, with three inches thigh atrophy and one and one-quarter inches atrophy of the calf. Operation July 8, 1896. The after-treatment consisted of a T-splint with eight pounds extension and 10 degrees flexion. Seven weeks later there was a good union. On August 26th she was up, and the apparent shortening was reduced so that a two-inch-high sole was sufficient to overcome it. Fig. 1 illustrates the amount of flexion before operation; Fig. 2 illustrates the spinal deformity in walking, due to the shortened and flexed leg; Fig. 3 illustrates the result.

CASE V. The fifth case is that of a boy (G. S.), nineteen years of age, who had suffered from hip disease five and one-half years. The hip was anchylosed in 70 degrees of flexion with 30 degrees of adduction. He was operated upon at the Carney Hospital on June 3, 1896. As a result of the operation he now has 15 degrees flexion and one-half inch apparent and two and one-half inches real

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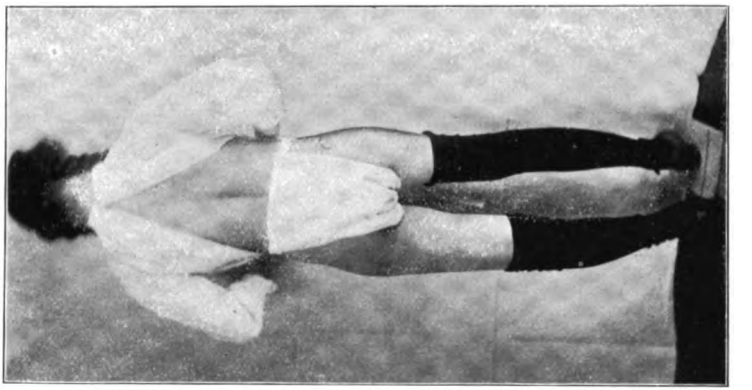
Fig. 3.



Case IV.
Fig. 2.

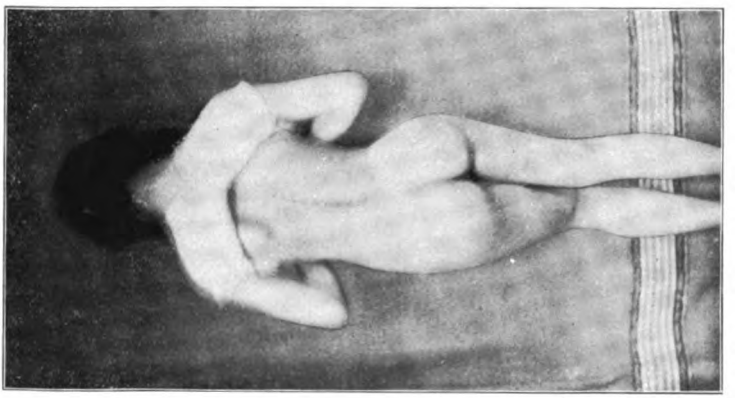
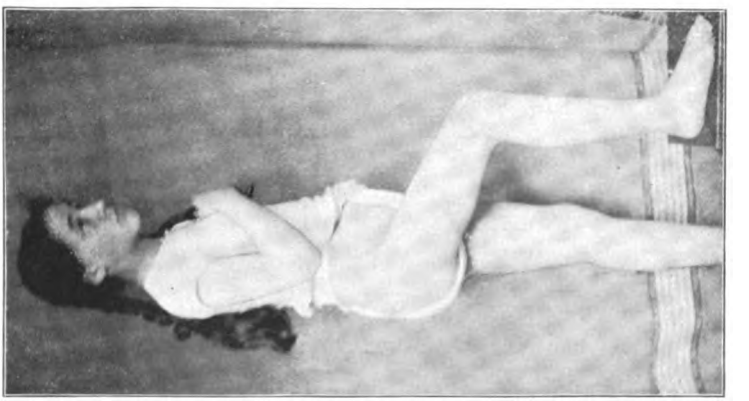


Fig. 1.



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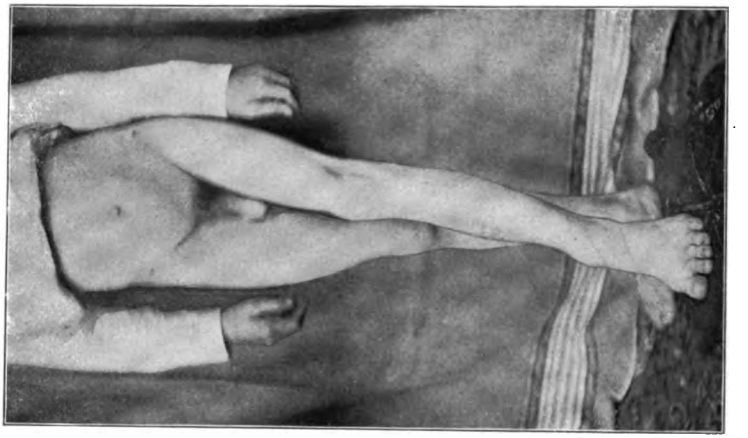


FIG. 6.

Case V.
FIG. 5.

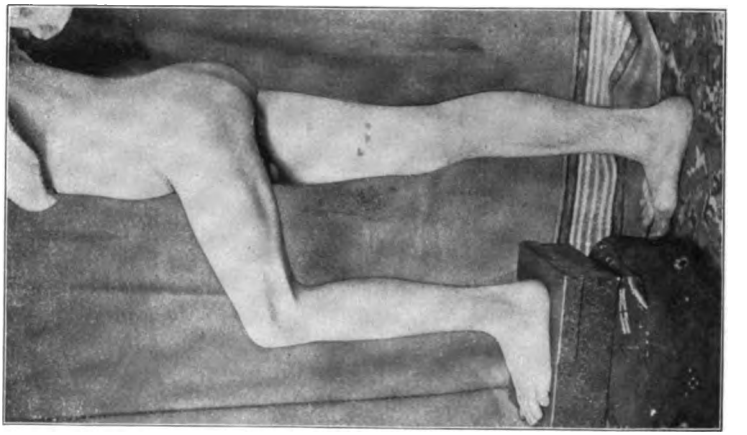
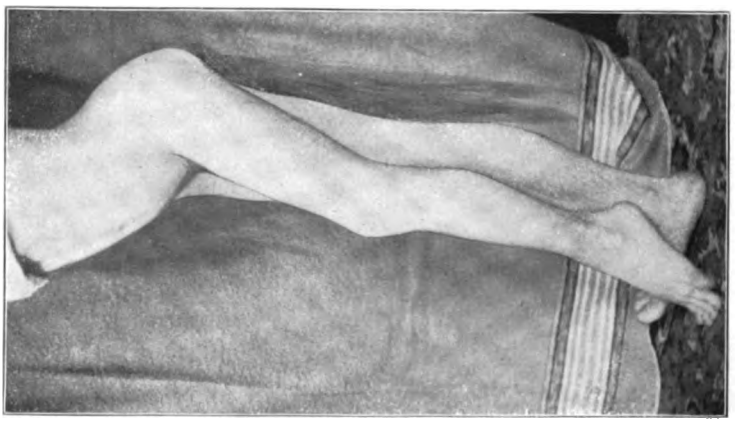


FIG. 4.



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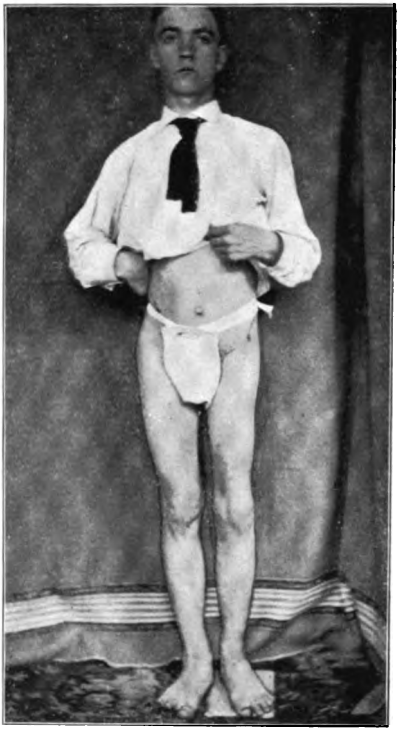
Case V.

FIG. 7.

FIG. 8.



shortening. The bed treatment continued seven weeks with weight and pulley, and one week longer in bed without apparatus. A cane was needed before but not after operation. Figs. 4, 5, and 6 illustrate the condition before operation, and Figs. 7 and 8 after operation.

CASE VI. This case (J. B.) was one of combined hip and spine disease, with great deformity. The patient was a youth, eighteen years of age. At two years of age he had Pott's disease, and four years later hip disease. He had treatment with apparatus for a time. Unable to do any work. Left hip dislocated on the dorsum; a few degrees of motion; adducted and very marked shortening, amounting to eight inches. Operated May 29, 1896.

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Case VI.

FIG. 9.

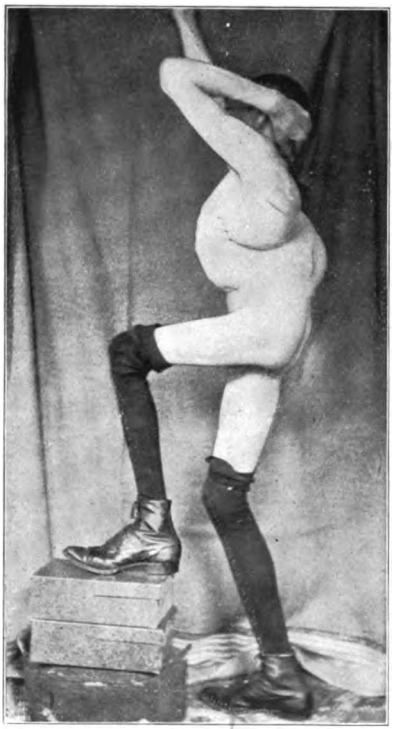
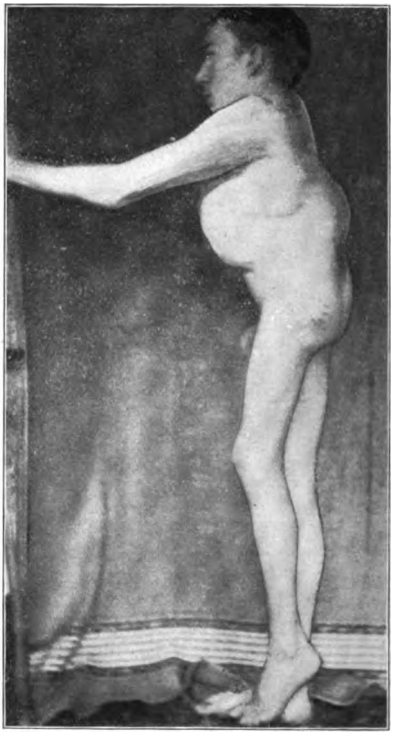


FIG. 10.



Union was delayed in this case on account of the osteotomy being done too far away from the trochanter. In the early part of September, three months later, however, union was firm, and he used a Thomas knee-splint for a time. A two-inch high sole accommodates the present shortening. Crutches were used before operation, and now he can get along with one cane. Fig. 9 illustrates condition before operation, and Fig. 10 the condition after operation.

CASE VII. This patient (M. K.) was a man, twenty-five years of age; another case of hip and Pott's disease with tremendous deformity. Disease began in childhood. He has never had treatment. At two and one-half years of age the disease began in the hip and spine simultaneously; there were numerous abscesses about

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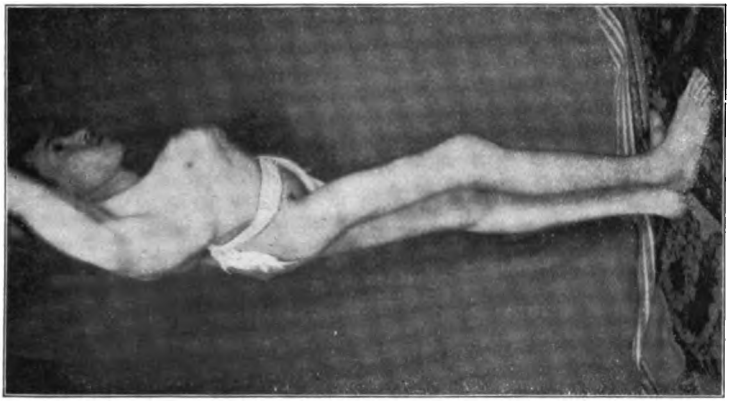
Fig. 13.



Case VII.
Fig. 12.

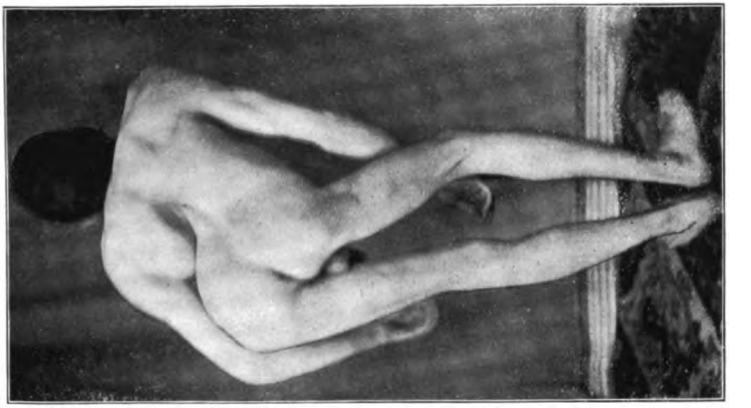
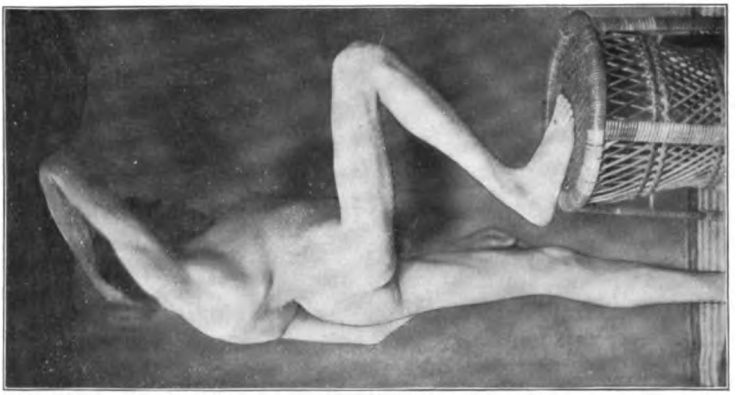


Fig. 11.



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Case VIII.

FIG. 14.

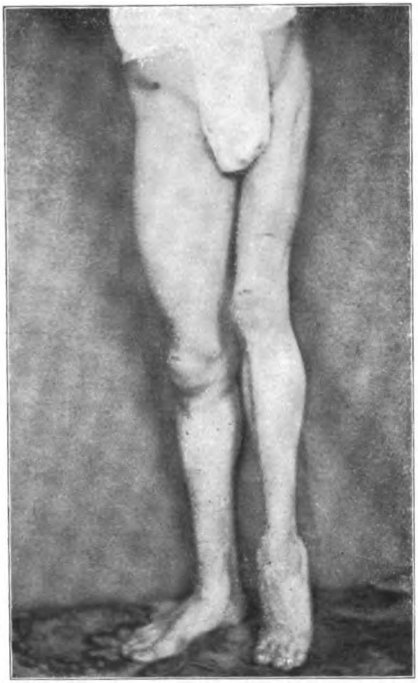
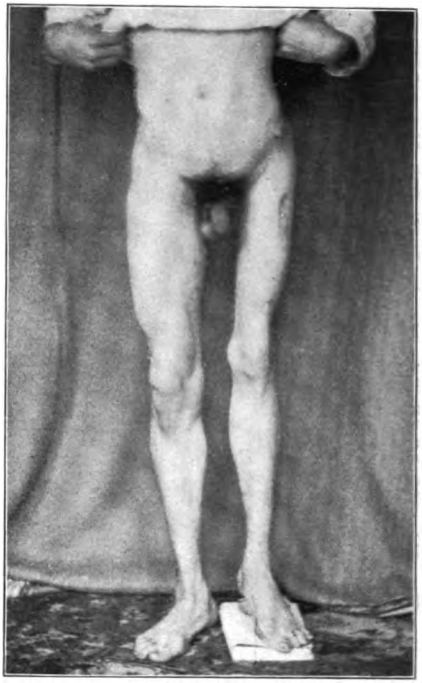


FIG. 15.



the hip, which healed at least twenty years ago. He had never done any work and had been dependent upon the city for support. He goes about now as he chooses, and is supporting himself at a trade which he has learned since his operation. The photographs show his condition very well: Figs. 11 and 12 illustrate position before operation, and Fig. 13 the position after operation.

CASE VIII. The next case (W. P.) was that of a young man, eighteen years of age, who had hip disease some years ago. Left leg adducted and flexed with very prominent trochanter. Thirty degrees of motion in flexion; one-half inch real and four and one-half inches apparent shortening. Curvature of the spine and slight discharge from one of several old sinuses on hip. He was operated upon February 25, 1897, and was discharged from the hospital nine weeks later. The femur was dislocated dorsally, and

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in the operation the adhesions in the new acetabulum were broken up. He, however, recovered very well with a few degrees of motion in flexion and one and one-quarter inch apparent shortening. During the first few weeks after his discharge from the hospital adduction seemed to be returning, so that on May 29, 1897, there were two and one-half inches apparent shortening; after that date there was no increase, and he now has 80 degrees of motion in flexion. No trouble arose from the discharging sinus, and it subsequently healed. Since this was written the old sinus opened and a superficial abscess formed below the trochanter. Fig. 14 illustrates adduction and shortening before operation, and Fig. 15 the position after operation.

CASE IX. The next case (J. McG.) was that of a boy, sixteen years of age. He was an old Children's Hospital case, entering the Out-patient Department in April, 1887; he was in the house from January to April, 1888, for a hip abscess. Had been treated with Thomas fixation-splint. He was provided with a traction and fixation-splint and discharged in April, 1888, only to return on two other occasions on account of the abscesses. His last record at the hospital, which was made in 1891, describes him as having 40 degrees permanent flexion, two inches actual shortening and one and one-half inches apparent shortening. This was in 1891. He is at present under treatment. It was impossible to maintain the corrected position with weight and extension, so a plaster spica was put on. He had a few degrees of motion left in the hip, so the thigh was put up abducted but not much flexed. At the present writing he is going about without crutch or cane and without flexion deformity and wears a patten.

CASE X. Boy, fourteen years of age (F. K.), operated on June 19, 1895. Hip disease since childhood. Recovered with 60 degrees of flexion and 25 degrees of adduction.

Result. Three and one-half inches real and one and one-half inches apparent shortening.

In such a series of cases the photographs tell most of the story better than any description could do, as far as the purely physical

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defect is concerned. The influence, however, of deformities of this nature upon the general health and mental condition, and the effects produced by the straightening, cannot be shown in any such way, nor even fully appreciated except by those who have come in contact with the patients. It certainly was not the least good that was accomplished for two of these men that they were enabled to get about and participate in affairs they never had dared hope for, and the effect in widening out the mental horizon for these poor creatures has been very marked.

It is instructive to note also how marked has been the improvement in the general physical condition of all of these patients. The importance of the operation in this regard cannot be too strongly emphasized—from the extreme difficulty in locomotion, especially when the attempt is made to get along without crutches or cane, the physical condition is kept at the lowest ebb, and the resistance to either the extension of the tubercular process or to the development of some other disease is much below the normal. Another point of interest is the fact that motion which is present in the partially anchylosed cases is preserved, so that fear of losing what little has been retained in these joints is no contraindication for operation. Cases III. and VIII. illustrate this point.

All of these patients of necessity had a lordosis and marked lateral curvature of the spine as the result of the position it was necessary to take in sitting or walking, and in several the symptoms which led them to seek treatment were entirely referred to the spine.

The operation performed in these cases was that described by Gant—the linear osteotomy being done as close below the trochanter as possible. The only instruments used were the osteotome and mallet. The after-treatment consisted in keeping the patient in bed for eight weeks and the application of a long T-splint reaching up to the axilla, maintaining the thigh in a position of abduction and flexion of about 15 degrees. An amount of traction sufficient to steady the leg was used. In two cases the plaster spica had to be employed because the patients tossed about too much to maintain the position. The side splint and traction method were found the more satisfactory because of the ease with which the position could be watched and corrected, when it was necessary. At the end of

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seven weeks the weights and splints were removed if union was firm, and the patients were kept in bed a week longer and then allowed to get up and go about on crutches. At the expiration of twelve weeks most of the patients have been able to use the leg without any artificial supports.

These cases add their testimony to the other reported instances of this operation, and show that great physical disability can readily be overcome with practically no risk and a comparatively short and painless convalescence; that the effect of physical deformity on intellectual development is very conspicuous, and that the benefit derived from the operation is as much along these lines in those of small mental calibre as it is in the correction of the deformity itself; that these deformities are capable of keeping down the general health to a point of slight resistance; that this is possibly more true in the more highly organized types of individual than of the lower grades; and that deformity can be corrected and motion preserved.

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ILIAC ABSCESS OF POTT'S DISEASE COMPLICATING FEMORAL HERNIA.

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AND

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We are all accustomed to think of the possibility of the abscess of lower dorsal and lumbar Pott's disease at times invading unusual regions, following the sheaths of muscles and appearing, not, as is their custom most usually, as a psoas abscess in Scarpa's triangle, but in the capsule of the hip-joint, simulating coxalgia, or in the femoral or inguinal canals, simulating herniæ. Where the abscess is an early symptom of the causative disease and the deformity is slight, errors in diagnosis may occur to the unwary, when the examination is limited to the locality of the tumor alone and is superficial.

Bradford and Lovett say: "Hernia is sometimes suggested by the appearance of a psoas abscess in the groin. Such purulent collections sometimes appear suddenly, are egg-shaped, and not hot or tender. They can sometimes be much diminished in size by gentle pressure, but they at once refill and present none of the characteristic features of hernia. They lie outside the femoral vessels in general, and the signs of Pott's disease are always present." Moore, in his *Orthopedic Surgery*, recently published, says: "Abscess is to be diagnosed from tumors and hernia. The location, together with the deformity and other symptoms of Pott's disease, should establish a diagnosis. A hernia would be in the inguinal or femoral canal. It would probably be reducible, and if composed of bowel would give tympanitic resonance and would not give fluctuation."

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On the other hand, we are not accustomed to think of hernia and Pott's abscess being coincident, and the absence of literature on this subject makes the case herein reported unique and worthy of record.

Mrs. B., aged thirty-one years, was sent to the Out-patient Department of the Hospital for Crippled and Deformed Children in April, 1896, by Dr. Howard A. Kelly for some spinal support, as she presented symptoms of Pott's disease. She gave the following history: She was of German-American parentage; father died of intermittent fever, but her mother was still living; two sisters died in infancy, and one sister died of general miliary tuberculosis and phthisis. Two maternal uncles died of phthisis in the same house in which they all lived. There was no history of any other member of her family having tubercular joint trouble.

The patient was healthy as a child and did not have any serious illness until August, 1893, when her second child was born, at that time it being thought she had "strained" her back. She had greater pain at the onset than subsequently, in the nerves of the dorso-lumbar region, and after a year an abscess formed, and was incised 10 cm. to the right side of the spine. This continued to discharge for eleven months, but was healed at the time she presented herself at the hospital. She complained of costal pain in the region of the ninth and tenth ribs, and especially on rising in the morning. Loss of flesh had been progressive, and weight at our first examination was eighty-three prounds. There had been no night-cries. Her appetite was fairly good, and all other bodily functions seemed normal. In February, 1895, the patient began to limp in the right leg, and when first seen the right knee was acutely painful over the internal condyle, white and swollen.

On physical examination the patient was thus described in the note then made: Patient is below the normal height (about five feet); lips and mucous membranes are of a fair color; nails normal; subcutaneous fat markedly lessened; superficial and peripheral circulation sluggish; chest well formed, and expansions equal on the two sides; abdomen normal and lymphatic glands nowhere markedly enlarged. A very slight knuckle is found involving the spine from the ninth dorsal to the second lumbar vertebræ, the apex being at the eleventh dorsal. On palpation no sign of psoas abscess

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can be made out, nor is there any psoas contraction. The heart, lungs, and abdomen are negative on percussion and auscultation.

Patient before operation, showing abscess invading the region of the femoral ring.

Muscular spasm is quite pronounced in the dorso-lumbar region and in the right knee, the latter showing fibrillar twitching on slightest jar or motion.

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Treatment. The patient was put to bed on a Bradford frame with piano-felt pads on either side of the knuckle. Buck's extension was applied to the knee with fifteen pounds of traction for ten weeks, during which time it was found necessary at times to use morphine, bromides, and asafœtida. On getting up a plaster-of-Paris jacket to the spine and cast to the knee were used, with crutches and high-soled shoe on the well leg. After wearing the plaster jackets for six months, the Taylor back-brace was substituted and the patient complained very seldom of any pain. Knee still showed muscular spasm on motion, but swelling was less, having been in circumference 37 cm. at mid-patella, 35.5 cm. 10 cm. above mid-patella, and 32 cm. 10 cm. below that point, when first seen; showed after six months' treatment 33, 35, and 30 cm. at the same points.

From July, 1897, to January, 1898, patient was much improved in every way, but on January 13th came to the Out-patient Department with a tumor in the groin, 10 to 15 cm. in diameter, just below and internal to the right anterior superior spine of the ilium. It was partly reducible, but refilled; it fluctuated, and was nowhere tympanitic on percussion. It had appeared two weeks before her coming to the hospital. On the 31st the patient was admitted, as no tendency toward absorption of the abscess was apparent, but rather an increase of its contents, and thinning of the skin was noted and aspiration was advised. Patient's temperature was 98.6° F.; pulse 100, and respiration 18 on admission.

On February 1st, 300 c.c. of creamy pus were withdrawn through the canula, followed by some bloody pus, when abscess cavity seemed nearly empty. Canula puncture was closed with collodion. On February 4th cavity had partly refilled and 80 c.c. more of pus were withdrawn. The nurse reported that the patient's bowels had not been moved for forty-eight hours, and that she had suffered much from nausea and vomiting. Quite an enlargement was noticed in the right groin, just above the region of the femoral ring, simulating hernia; it was not reducible, and no fluctuation was made out, and it was thought to be a pocket of the iliac abscess. A grain and a half of calomel followed by a glycerin enema was given, with two slight stools as a result.

February 6th. Nausea, vomiting, and constipation persisted.

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A sausage-shaped mass, 4 x 7 cm., was seen in the right groin, which did not extend to the labia internally, and externally reached to the margin of the iliac abscess. It was hard and had a small point of fluctuation in its centre, near, but above, the femoral canal. Operation was decided on, as the symptoms pointed to strangulated hernia.

7th. Urine examination showed a slight trace of albumin but no casts. Temperature 101.5°; respirations 24; pulse 124 on the morning of the operation. An incision was made obliquely from right labium to and through iliac abscess, as hernial canal was found to communicate with it. A "boot"-shaped mass was brought to light, the "leg of the boot" extending into the abdominal cavity through the femoral canal. The color of the mass was bluish and congested, but not actually necrotic; it was firmly bound down by adhesions. On dissection "the boot leg" was found to be the strangulated gut, and "the toe" and "heel" the hernial sac filled and tense with serum. This sac was removed, bits of omentum and the gut were returned to the abdominal cavity, the hernial ring was sutured with interrupted silver sutures, and the skin wound as far as the iliac abscess was sutured continuously and subcutaneously with silver wire. The iliac abscess was then curetted and found to extend back along the iliac crest, then packed with iodoform gauze, the whole covered with silver foil and dressed in the usual manner. On the second day after the operation the bowels moved naturally; there was great thirst, but no nausea or vomiting. On the fourth day, as the temperature had risen to 103° F., the dressings were taken down; the hernial wound was found closed securely and perfectly healthy and dry, while there was but little bloody tubercular pus in the cavity of the iliac abscess. A portion of the hernial wound was torn open, but no evidence of any burrowing or sepsis was found, and the healing of the hernial wound was uninterrupted.

The temperature ranged from 98.6° in the morning to 101.5° or 102° in the evenings, on an average, for forty days, when the patient was discharged with a small sinus from the iliac wound persisting. The pulse ranged from 96 as a minimum to 140 as a maximum on one occasion during this period of convalescence, and the respiration from 20 to 28.

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There seems to be but one point in conclusion which should be mentioned as a probable etiological factor in the causation of this double condition, and that is the weight of the plaster cast on the knee, dragging on the femoral canal, whose resistance had been lowered by the maceration of the adjacent tubercular pus, and should be a caution against the employment of too heavy casts in the treatment of tumor albus.

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SOME PRACTICAL POINTS IN THE ANATOMY OF THE FOOT.

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BOSTON.

AND

F. J. COTTON, M.D.,
BOSTON.

THE aim of the present paper is to study the conditions met with in the pronated foot as distinguished from the flat-foot. By pronation is meant that vicious attitude of the foot in which, in habitual standing position, it rolls over inward, the inner malleolus projects, and abduction of the front part of the foot occurs. Up to a certain limit, which has not been correctly determined, this movement occurs in the normal foot; beyond this limit it must be regarded as pathological, and is likely to be attended by symptoms of pain and disability. Correction, active or passive, to normal position is usually easy in the milder cases, and the foot after being corrected shows no flattening of the arch, though the symptoms complained of may even be identical with those of flat-foot.

This class of cases is referred to also as weak foot;[1] in children the condition is commonly called weak ankles. The distinction between it and flat-foot is, however, often imperfectly appreciated.

The pathological alterations in advanced flat-foot have been carefully established by a number of dissections of such cases,[2] and there

[1] Whitman: New York Medical Journal, November, 1895. Lovett: TRANSACTIONS AMERICAN ORTHOPEDIC ASSOCIATION, vol. viii. p. 78. Dane: Ibid., 1897. Lovett and Dane: New York Medical Journal, March, 1896.

[2] Dittel, cited by Albert: Wien.med. Presse, 1881, p. 19. Hueter: Langenbeck's Arch., 1862, vol. iv. p. 498. Henke: Ztschr. f. ration. Med., 1859. V. Meyer: Entsteh. des Plattefusses, 1883. Lorenz: Plattfuss, Stuttgart, 1883. Symington: Journ. Anat., 1884, vol. xix. p. 83. Chaput: Progrès Méd., 1886, vol. xiv. p. 857. Humphrey: Lancet, 1886, vol. i. p. 529. Stokes: British Medical Journal, 1894, vol. ii. p. 1224. Kennedy: Glasgow Medical Journal, 1894, vol. xlii. p. 198.

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seems to be fair agreement between authors as to the actual changes, except in regard to the stretching of the calcaneo-scaphoid ligament. The mechanism of production has had many different interpretations. It is probably to be accepted, v. Meyer to the contrary notwithstanding, that the calcanoo-scaphoid ligament is stretched, at least usually. As to the theories of mechanism, the most plausible are those of Lorenz and v. Meyer. Both recognize the early pronated position, but, while v. Meyer believes that pronation goes on to flattening, Lorenz assumes that the outer arch, on which, according to his scheme, the inner arch rests, must break down before the inner arch slides off it downward and inward.

This classification of the production of flat-foot is of interest in the present connection only in so far as the study of less severe cases of static disorders of the foot may throw light on the mechanism which causes the severer cases.

What interests us at present, however, is the determination of the actual anatomical conditions in the less severe forms of static disorders, and a study of their causes, avoidance, and treatment. Such cases are, in this community at least, far commoner than fully developed flat-foot, yet most writers seem to fail to recognize them as forming a distinct class, and even when they have been so recognized, the pathology has not been worked out.

This investigation was undertaken by the writers in a spirit of inquiry. They had no theory to prove, and, after observing clinical facts, they passed to anatomical studies, for opportunity for which they are indebted to Prof. Thomas Dwight, of the Harvard Medical School.

In contrast to the word pronation the word supination will be used here to designate the corrected position of the foot in which, by the influence of voluntary muscular contraction, the foot is placed with its outer border touching the ground, in its normal relation to the leg, with the inner malleolus not unduly prominent. Supination is a position of active muscular control and strength. Pronation is the position of ligamentous contrasted with muscular support, and is the position of weakness (Fig. 1).

It was first sought to determine whether pathological and physiological pronation are identical in the site and direction of the movement, to compare the range of movement in the two cases, and to

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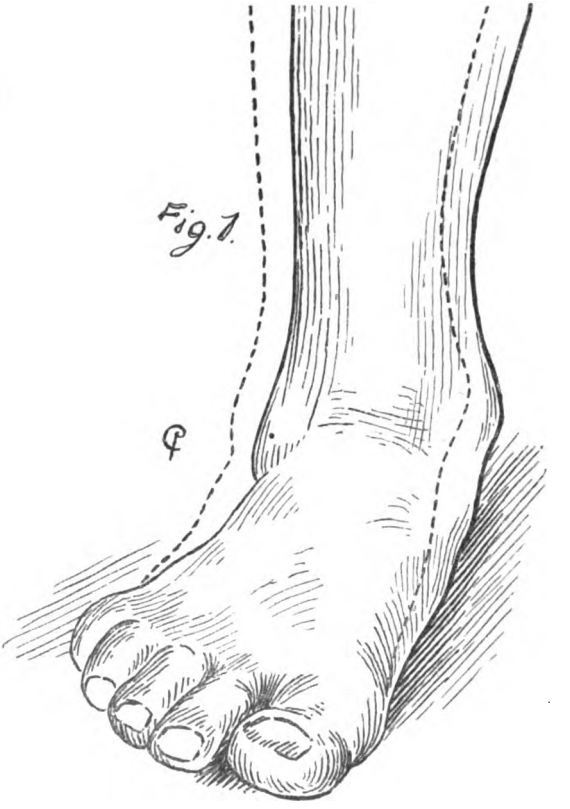
determine whether the functionally imperfect feet studied showed any bony or other permanent change.



Pronation (from photograph). Position of correction shown in broken line.

For this purpose cases were selected with unserviceable feet, with more or less abnormal standing position, other cases without symptoms but of the same general appearance, other sufficiently good feet with a wide range of movement in the standing position, and others which must be classed as approximately normal. In all some sixty cases were studied.

X-RAYS. The first method of study was with the x-ray. Photographs were taken of eleven cases of normal and pronated feet, and, for comparison, of three flat-feet with marked, two of them with

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extreme, bony change. The feet were photographed in two or three directions, from the inside, from above, and from the outside; where correction was possible the same foot was photographed in the two positions of supination and pronation. In photographing the two positions the foot was allowed to sink or was corrected to the required position, and a fresh plate was adjusted and exposed in the same place, neither the sole of the foot nor the tube being moved. In all cases a definite measured distance of the tube from the plate was used, and the foot was placed in constant relation to both. For the lateral views the tube was placed at the height of the astragalus; for the views from above, the centre of the tube was placed directly over the centre of the front edge of the plate. The views were taken with the foot in a position of slight toeing-out, and as nearly as possible with each foot bearing an equal part of the body-weight.

In this way there was obtained a series of negatives in which the error of distortion seems to have been reduced to a minimum, for whatever distortion was present, under this constant relation of distance and angle, must be approximately reproduced in each and every plate. These plates were compared by overlaying accurate tracings of the negatives, a method which proved much more serviceable than the use of prints, or of the negatives themselves; forty-four negatives were taken, of which forty-one proved available for comparisons. This study of the series showed:

1. Save in the cases of advanced flat-foot, which showed the changes described as classical, and developed nothing new (see Figs. 5 and 6)—save for these, none of the cases showed appreciable bony change. The individual variations in shape and relation of the bones were considerable, especially as regards the angle with the horizontal of the long axis of the calcis, but a study of many sets of dry bones, examined in this connection, convinced us that the variations seen in the negatives fell within the normal limit (Figs. 2 and 3).

To this there is one exception. In feet which are habitually considerably pronated, whether functionally intact or not, there seems to be some prolongation upward of the anterior surface of the astragalus, showing in the corrected position as a rise behind the scaphoid.

2. No distinction can be drawn between the relation of bones in the painfully pronated foot and that of the relatively normal foot when allowed to pronate; nor between the normal standing position

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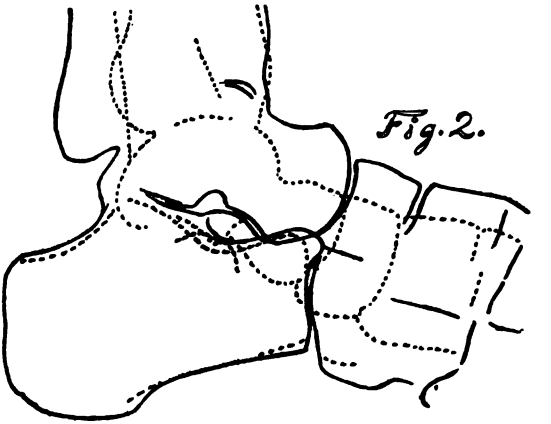
of supination and that which may be temporarily assumed in correction by feet which are habitually pronated (compare Figs. 2, 3, and 4). The range of movement is very variable, but it seems to have no definite relation to the presence of symptoms, to the usefulness of the foot, or to the position assumed in ordinary standing.

3. The movement of pronation consists in the following changes of position:

(*a*) The foot as a whole rotates beneath the astragalus toward the position of valgus. This is seen on the x-ray plate of the lateral view by comparison of the relations, in the two positions, of scaphoid and cuboid, and is also obvious in the view from above. The valgus



A painful pronated foot (x-ray tracing). Dotted line shows standing position—full line that of voluntary correction.

rotation of the calcis is best seen in side view by comparison of the relative positions of the sustentaculum tali and the line of the upper surface of the calcis. The maximum extent of rotation (between pronation and supination, in standing) was in one case about 14 degrees. This was readily determined by setting up dry bones to correspond to the positions indicated by the tracings. The valgus rotation of the front foot seemed to be somewhat more than that of the calcis, but could not be accurately estimated in degrees.

(*b*) The astragalus so rotates in pronation that its head moves inward and backward, its body and outer portion outward and forward. This is obvious in the bone itself, and is accompanied by the

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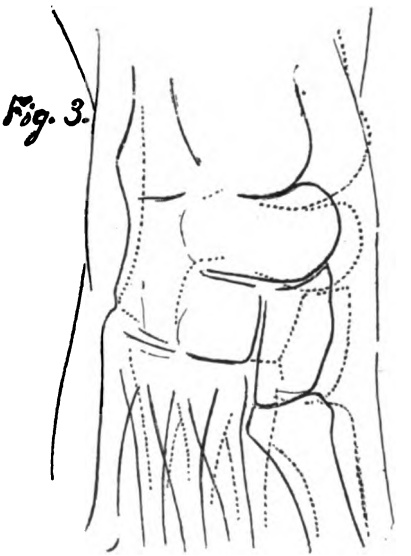
very obvious change in position of the malleoli which, of course, move with it in this rotation, the inner malleolus backward and the outer forward. There is at the same time a plantar flexion of the astragalus by which its head sinks toward the sole.[1]

(*c*) There is some movement outward of the cuboid on the calcis, hard to estimate accurately by the x-ray on account of the irregular contours of the bones.

(*d*) Associated with this is a movement outward of the front foot, taking place between the scaphoid and the astragalus, by which the head of the astragalus, rotating inward, is in part exposed.



A painful pronated foot (x-ray tracing). Dotted line shows standing position—full line that of voluntary correction.

(*e*) Anterior to this point no change of relation of the bones is to be made out, the whole front foot, including scaphoid and cuboid, moving essentially *en masse*.

Neither in extent, nor direction, nor site of these movements, does

[1] All these movements have been recognized and described as occurring in the movements of the normal foot, but not in the "pronated foot." v. Meyer: Statik u. Mechanik des menschl. Fusses. Golobiewski: Ztschr. f. Orth. Ch., 1894, vol. iii. p. 243.

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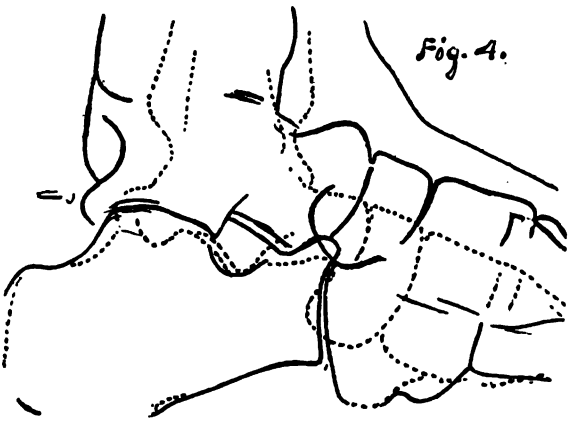
there seem to be any constant difference between the movements of the relatively normal and pathologically pronated foot.

ANATOMICAL DATA. The results of the x-ray studies were checked by anatomical observations, not only of dry bones, but of the cadaver in various stages of dissection. The material placed at our disposal by Dr. Thomas Dwight did not consist, it may be said, of dry or drying specimens, but of either alcoholic specimens of ligamentous dissections, or of dissections of relatively fresh cadavers moistened to a practically normal flexibility. To determine the movement of the bones one upon the other, long pins were driven into each of the



A very mobile foot. No symptoms. Full line shows position of supination, dotted line that of voluntary pronation.

various bones, and with the foot bearing weight the positions of pronation and supination were produced. The movements of the free ends of the pins gave a correct means of determining the movements taking place between the bones, and a very close correspondence in detail was found with the results of the x-ray photographs. Only in one respect was there a difference worthy of note; in the cadaver less valgus rotation of the calcis and more motion between the cuboid and os calcis were found under similar conditions of pronation than the x-ray photographs had led us to expect. Whether this means a laxity of ligaments in cases which show free valgus rotation of the os calcis is not certain. It must be remembered that there is great

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individual variation in the shape of the os calcis and in the relation of its long axis to the ground, hence, even apart from the variations in form of the joint surfaces (which are marked), there must be a different proportion between the horizontal and vertical components of rotation as affected by these variations—that is, where the posterior joint between astragalus and calcis is naturally nearly horizontal, pronation will consist more largely in abduction than in valgus rotation of the calcis beneath the astragalus. This is the probable explanation of the differences noted in different feet, and is important, inasmuch as it shows that measurements of the valgus rotation of the calcis alone cannot give a just estimate of the movement in pronation.

The abduction of the front foot is not directly dependent on the rotation of the calcis, but rather upon the horizontal rotation of the astragalus. The head of the astragalus, which is roughly spherical, moves in a ball-and-socket joint formed by the sustentaculum tali, the calcaneo-scaphoid ligament, and the scaphoid. This allows of free movement, but the relations of surface are such that an inward rotation of the head of the astragalus (when the foot is under weight) determines an outward movement of the scaphoid swinging on the calcaneo-scaphoid ligament. Conversely, if the relation of the scaphoid to the calcis is fixed, with the foot-bearing weight, no inward rotation of the astragalus is possible. It is in this way rather than by supporting the head of the astragalus directly, as is sometimes stated, that the tibialis posticus prevents pronation. This may readily be shown in the cadaver by nailing the tendons of this muscle to the tibia, when pronation is checked. Conversely, in some specimens where the muscles and tendons are intact, pronation is limited by this muscle, and if its tendon be cut or slipped from its groove, pronation to a much greater extent is possible.

This somewhat complicated relation between astragalus, scaphoid, and ligaments also determines the mechanism by which the front part of the foot-sole is kept flat to the ground. As the foot is supinated, there is a movement downward of the scaphoid over the head of the astragalus as well as the movement inward just described. When the foot is rolled outward in supination, this plantar flexion of scaphoid, cuneiform, and inner metatarsals acts to compensate, and the inner side of the ball of the foot still remains in contact with the ground.

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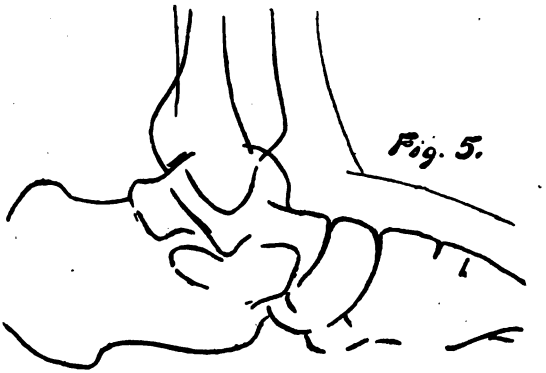
This compensation has a practical bearing, and will be referred to later.

It is to be noted that the astragalus has no muscular insertions, and acts simply as a transmitter and the sole transmitter of the body-weight. Once movement of the astragalus is permitted by the muscles, its movements and the movements of the tarsal bones beneath it are determined only by the relations of the joint surfaces—though ligaments may limit their extent.



Rigid flat-foot.

With the scaphoid in its movement in pronation outlined above, the whole front foot moves in abduction, the scaphoid, cuneiforms, and cuboid moving substantially *en masse*. The cuboid movement on the os calcis is limited by the play of a process on its posterior articular surface with a corresponding groove on the calcis. The movement in pronation is outward on the calcis with a slight twist-up of the outer edge of the cuboid.

To sum up, the movements of pronation consist of the horizontal rotation of the astragalus with the sinking of its head, the rotation in valgus of the calcis beneath it, and the rotation in valgus and abduction of the front foot as a whole, occurring between astragalus and scaphoid, calcis, and cuboid.

The practical immobility of the front foot itself under weight, noted in the x-ray views of abnormal and relatively normal feet, proved true also on the cadaver. Movement between the bones of the front foot is permitted in the direction of plantar flexion when the foot

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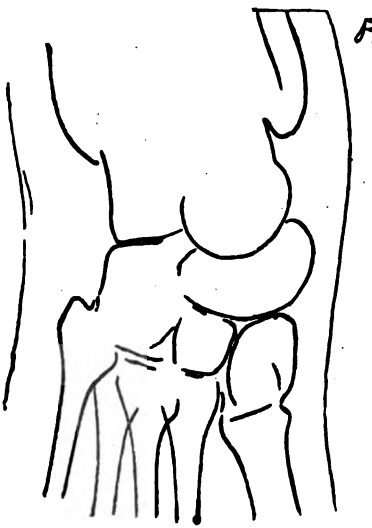
hangs free, and no doubt active plantar flexion, through muscular contraction, must help in the accommodation of the sole to any surface, even under weight, but in the passive weight-bearing position on even ground the bones seem to be practically locked together by the action of the plantar ligaments, holding together joint surfaces which are not constructed to allow lateral movement. This locking is not absolute, except, perhaps, for the third metatarsal, but the range of movement between these bones in weight-bearing is, we think, far less than seems to be usually supposed. Interesting in this connection is the fact that, as plates of dissections show, the bony changes even in advanced static flat-foot involve the cuneiform



Rigid flat-foot.

and metatarsals hardly at all. This would seem to indicate the relative strength of this portion of the foot.

MEASUREMENT OF THE ROTATION OF THE ASTRAGALUS. In order to have some definite measure of the amount of anatomical pronation, the measurement of the horizontal rotation of the malleoli was fixed upon.[1] The astragalus being firmly fixed in the malleolar

[1] The attempt to use this rotation as a measure has been made before, but by less exact methods. Lovett: New York Medical Journal, June, 1895. Dane: Loc. cit.

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mortise, so far as lateral motion goes, the malleoli take part in the horizontal excursion of the astragalus, which is an essential element in pronation. As to the accuracy of this measurement as a measurement of pronation, it can be said that pronation is invariably accompanied by rotation of the astragalus, and increased pronation by increased rotation in what seems to be a constant ratio. The measurement has been carefully and repeatedly tested, not only clinically, but on the cadaver and on ligamentous dissections as well; and it seems that, while it is not an accurate measurement of the valgus rotation of the calcis, yet, giving as it does an index of the abduction of the front foot (which has been shown above to bear a relation to the horizontal rotation of the astragalus as such), it is a fairly accurate measure of the pronation of the foot as a whole, though not mathematically accurate, as no measure of pronation can be.

This rotation we have measured as follows: A clip was constructed with sliding arms to grasp the external malleolus at its back edge, the internal at its prominent anterior portion. (See Fig. 7.) These are the only anatomical points which are constantly available clinically, and proved on examination of cadavers to bear a very constant relation to the axis of the ankle-joint (an error at the maximum of but four degrees, and averaging much less). The clip bears two projecting rods on the sliding arms which form a prolongation of a line passed through the two points on the malleoli just noted.

In using this instrument the patient stands bearing the weight equally on both feet, the direction being given to stand as naturally as possible, the patient being allowed to stand in any position of eversion which he or she may select as the ordinary standing position, or a fixed angle of divergence of the feet is chosen. From these two rods projecting from the clip a perpendicular was dropped by means of a rule or a piece of paper folded vertically, and the points representing the bottom of the perpendiculars were marked on the paper on which the patient stood; a thick ruler was then placed along the inner side of the patient's foot and a line drawn along it; the foot was then removed from the paper and the two points representing the perpendiculars from the rods were connected by a line, and the angle made by the two lines was measured (angle

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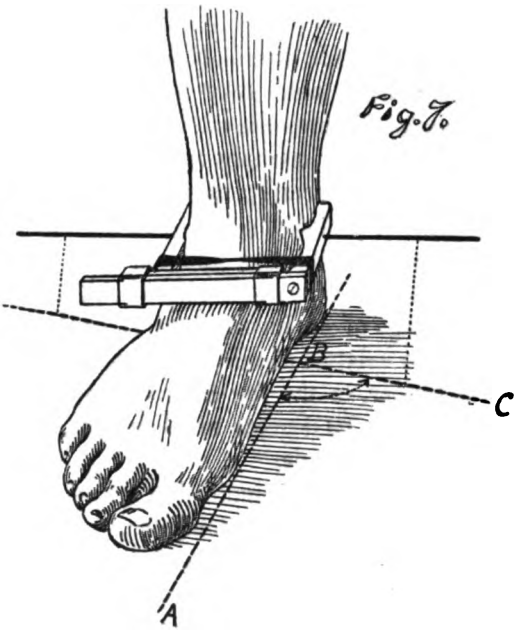
ABC, Fig. 7). The error of the actual measurement proved very small, a matter of a couple of degrees or less.

This measurement gives, of course, at best, simply the measurement of pronation in such feet as are without much bony change—the more usual condition. In flat-foot proper it can only be a measure of the position of the astragalus, and not a true measure of pronation.



This angle, with its variations, was studied in 119 measurements on 51 cases (beside measurements on 14 undissected cadavers). In this series we find:

(*a*) The angle varies in natural standing from 46 degrees to 73 degrees.

(*b*) In people with the better class of feet it is below 60 degrees.

(*c*) The normal we should set at about 50 degrees.

(*d*) People with painful feet are likely to have a higher angle, 60 degrees or 70 degrees.

(*e*) Competent feet show an appreciable, often a considerable, in-

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crease of the angle over that of ordinary standing, when the foot is voluntarily allowed to roll inward; it may be said that they have a reserve of pronation.

(*f*) When there is no such reserve of pronation one is likely to find symptoms.

(*g*) The angle varies with position, being greater in the position of divergence of the feet when this divergence is over 30 degrees. With the feet toeing-out at 90 degress this increase in the angle may be considerable.

(*h*) One finds feet which have a reserve of pronation when toeing-in or parallel—none when they toe-out. This condition also seems connected with the presence of symptoms.

(*i*) There is a curiously constant maximum of 71 degrees to 73 degrees in the cases measured by us, which would seem to indicate the anatomical limit of pronation; but dissected feet show individual maxima, determined by ligaments, which in some cases are several degrees less than this. The occurrence of this maximum angle is not necessarily a sign of an incompetent or weak foot, unless this angle represents the habitual standing position.

(*j*) Flat-feet proper, in the few cases we have measured, record about this same angle, 70 degrees to 73 degrees, whether they are of the fixed or the mobile type.

(*k*) The actual angle, though indicating the anatomical condition, is only a rough indication of the competency of a foot. A large angle indicates at most only a mechanical disadvantage in standing, and considerable pronation, shown by this as by the other measures, may exist in a foot which is not only painless but mechanically sufficient for the person's needs.

This measurement of angle is of most value in comparing the pronation in different positions of the same foot, or in comparing the two feet of an individual in the same position. However, though it is undoubtedly subject to some error, as all measurements of pronation must be, from the normal variation in the shape of the tarsal bones in different individuals, yet it appears to us the most accurate index of anatomical pronation yet proposed, and sufficiently accurate to be of definite value.

In a number of cases the relation of the internal malleolus to the weight-bearing areas was observed and measured. This was done

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by tracing these areas on the under side of a glass plate on which the patients stood, dropping a perpendicular from the internal malleolus to the glass, marking this point, tracing off the areas and the point so obtained, and measuring the distance from said point to a line joining the inner edge of the anterior and posterior areas of weight-bearing. This distance must, of course, represent in some degree the mechanical competency of the foot as a passive support, or, conversely, the disadvantage to be overcome by muscular action, and that more accurately than v. Meyer's triangle method, since the weight-bearing surfaces do not necessarily correspond to the anatomical landmarks. The scheme did not prove serviceable as an index, however; the measurement is too rough a one.

The old-fashioned smoked-paper imprints were taken in some cases, but were of use only in helping us class, according to older standards, the cases studied. The "flat-foot print" fails to differentiate between the fleshy padded, the œdematous foot, and the flat-foot, except in cases of advanced deformity, where mere inspection does as much. It equally confuses the lifted outer edge of many pronated feet and the naturally high arch; is, in short, practically nearly worthless. How worthless it is a recent paper by Dr. John Dane, in criticism of data previously accepted from imprints of children's feet, will clearly show.

Observations by the glass-plate method are open to objections similar to those urged against the imprint method, though its data are more readily controlled by the eye. Besides this it does give definite information as to the tiring reaction (that rolling inward of the foot which is sometimes to be seen after a few moments' standing in one position) and also enables one to judge not only of the areas of weight-bearing but also of the relative distribution and amount of pressure.

By aid of this method it was possible to demonstrate in certain cases that correction of the foot back to approximately the normal standing position caused a considerable lifting of the inner edge of the anterior weight-bearing areas—producing a very abnormal outline.

In some cases which might be classed as pronated feet, as well as in mobile flat-foot, this lifting of the inner edge, on correction of pronation, is readily appreciable without the aid of the glass plate.

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In view of the mechanism of adjustment of the sole to the ground, above described, it must mean either stretching of the calcaneo-scaphoid ligament or else bony change. In either case it has a practical bearing, as showing greater strain on the muscles, if the patient tries to stand properly, and is theoretically important as serving to show that the inner side of the foot gives way first. It is worth noting that we have seen no evidence in our cases of early breaking down of the external arch in pronated feet or in the intermediate stages. So far as they go, then, our data tend to confirm v. Meyer's theory of flat-foot production rather than that of Lorenz.

Before passing to treatment certain points may be emphasized of more direct interest from all this mass of detail.

(*a*) There is a frequent class of feet, often disabling, which have nothing in common with flat-foot, anatomically, save the pronation.

(*b*) This pronation involves no appreciable change in the bones or ligaments in the majority of cases, and correction of the vicious standing position gives a full anatomical correction. What determines the further progress toward flat-foot cannot be said. Hoffa and of late Nasse[1] are inclined to assume a yielding bony structure as at least a frequent cause.

Intermediate stages are seen, but the great class of pronated feet should be held separate clinically from flat-foot, especially in regard to prognosis of treatment.

(*c*) The occurrence of symptoms seems to depend essentially on the reaction to overstrain of ligaments and muscles, and is apparently the result of a degree of pronation such as to bring the burden of support for a great part or the whole of the day on the ligaments. This necessary degree of pronation varies widely, and would seem to be indicated not so much by the absolute degree of pronation as by the disappearance of the reserve of pronation. There is, of course, much individual difference of reaction, and certain cases seem to stand habitually with full strain on the ligaments, and do heavy work, yet have no symptoms.

(*d*) This reserve of pronation, which seems of some importance, may be accurately measured by the angle method proposed.

(*e*) The measurement of the angle gives a record of the anatomical

[1] Hoffa: Langenbeck's Arch., 1895, vol. l. p. 40. Nasse: Deutsche Chir., Lief. 66, I. Hälfte, S. 181.

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pronation existing, and is of value in showing the mechanical disadvantage to be overcome by muscular correction, and for estimating the degree of support required, or the value in correction of a given supporting apparatus.

TREATMENT. In the treatment of pronated foot the end aimed at is correction into that position of moderate supination which is normal in standing. The maintenance of this position is normally largely dependent on the muscles. If the patient can be induced to learn to be conscious of pronation, and to correct voluntarily by muscular action, much will be gained. If the muscles are weak, systematic exercises—as outlined by Ellis, Roth, and adopted by other writers[1]—will help.

The disadvantages under which the foot works must be minimized by avoiding toeing-out in walking or standing.

The importance of proper shoeing need not be dwelt on here; its importance has been fully and often explained. A further lessening of mechanical disadvantage may be accomplished by the use of the Thomas sole.

Many cases, however, require some actual mechanical support, for a time at least, for muscular control is only gradually learned, even if the patient persists, as many do not, and often it is necessary to give the stretched muscles a period of rest before they can take up their proper function. The simplest form of support is the felt pad beneath the inner arch, often most efficient as a temporary measure. In the same category comes, for acutely painful cases, the application of adhesive plaster strips from the outer side of the foot, beneath the sole, and up the inner side of the ankle and leg, holding the foot in the desired supination. This method is especially serviceable if combined with the felt pad.

For firmer support metal plates have been the usual scheme. As ordinarily applied they are open to several objections:

(*a*) They are clumsy.

(*b*) They interfere with the action of the muscles, and make constant pressure on the muscles of the sole of the foot.

(*c*) Either they do not embrace the outer side of the foot at all, in which case the foot tends to slide off outward, and bears excessively

[1] Hoffa: Loc. cit. Whitman: Boston Medical and Surgical Journal, 1888.

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on the outer side of the boot. Such a plate lacks efficiency as a support, and may be a cause of discomfort.

(*d*) Or they support the outer side of the foot at one point only, thereby losing a valuable point of support, in that they do not directly work against the abduction of the front foot on the calcis.

(*e*) They act ordinarily more as support from beneath than as

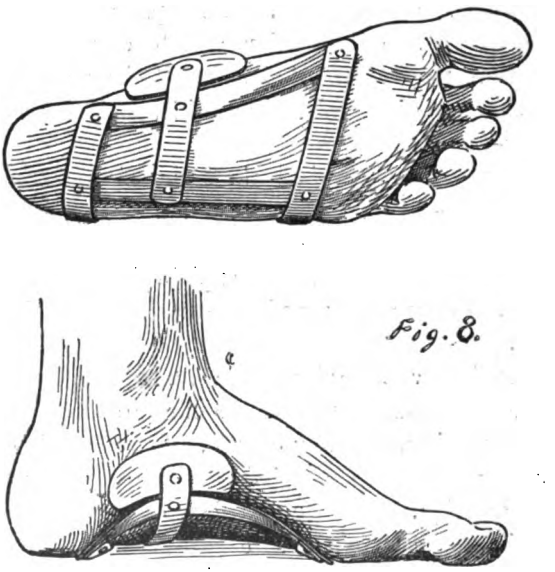

Fig. 8.

direct aids against inward rotation, and often simply transfer the point of weight-bearing without ensuring full correction of the vicious position of the foot.

These objections we have tried to avoid in an apparatus which is herewith presented (Fig. 8). It is relatively light, seems, being an elastic skeleton, to give comparatively free play to the foot muscles, and corrects satisfactorily, preventing extreme pronation, resisting pronation in lesser degrees, and even in the corrected position fitting the foot closely, with slight lateral pressure outward. It is supported on the boot sole, front and back, on the inner side, so gaining an effective fulcrum. The pressure on the foot comes to some extent as moderate elastic support of the inner side from below, but mainly

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as elastic pressure outward applied just below the tuberosity of the scaphoid.

At the outer side are two points of support, and the action of the plate under weight is to produce a relative adduction of both the front foot and the hind end of the calcis—that is to say, to carry the cuboid into supination with relation to the calcis. In this way correction is obtained by lateral thrust and counter-pressure, which corrects more certainly than support beneath, and interferes much less with the normal bearing of the ball of the foot on the boot sole.

The apparatus is made of strips of spring steel, eighteen or twenty gauge, riveted together as shown, made to fit a cut-out plaster cast, which is taken in the corrected position. The pressure-plate is of aluminum bronze. The whole apparatus is then fitted to the foot before tempering; the bars along the inner and outer side and the anterior cross-bar permit a good deal of actual support to be given locally where it is needed, as in cases where it is desirable to support the anterior arch. After fitting, the apparatus is given a spring temper and is covered with leather, a thin pad of felt being fixed between the leather and the pressure-plate, if necessary.

The apparatus is not intended for flat-foot or for feet with any appreciable bony change, nor for heavy patients. There are also cases of uncomplicated pronation which may for a time need a rigid support; for such cases of whatever class, a plate on the lines of Whitman's, but furnishing two points of support externally, would seem to meet all requirements; often a simple arched steel plate without external support will suffice.

For the ordinary pronated foot, however, the apparatus here presented seems, so far as we have used it practically, sufficiently light and comfortable, checks vicious standing and tends constantly to correct pronation, while to some extent permitting the normal muscular use of the front foot, and allowing the rotation of the foot incident to its normal use. In this way it favors a normal gait, and facilitates the active use of the foot, which is necessary if we are to attain a cure, not merely the alleviation, of the pronated foot.

In closing, it may be said that this paper, in so far as it relates to treatment by apparatus, is a preliminary one only.

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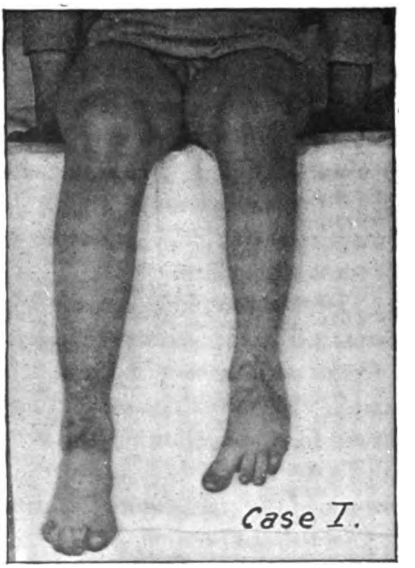
CONGENITAL DEFECT OF THE FIBULA.

By T. J. COTTON, M.D.,
BOSTON.
AND
A. L. CHUTE, M.D.,
BOSTON.

THE cases we have to report are of those classed in the literature either as congenital defect of the fibula or as intra-uterine fracture of the tibia, according as the one or the other feature has chanced to impress the individual observer.

FIG. 1.



CASE I. The first case, G. H., a boy of seven years, was an inmate of the Marcella Street Home. There was no history of trauma at or before birth; no deformities noted as having occurred

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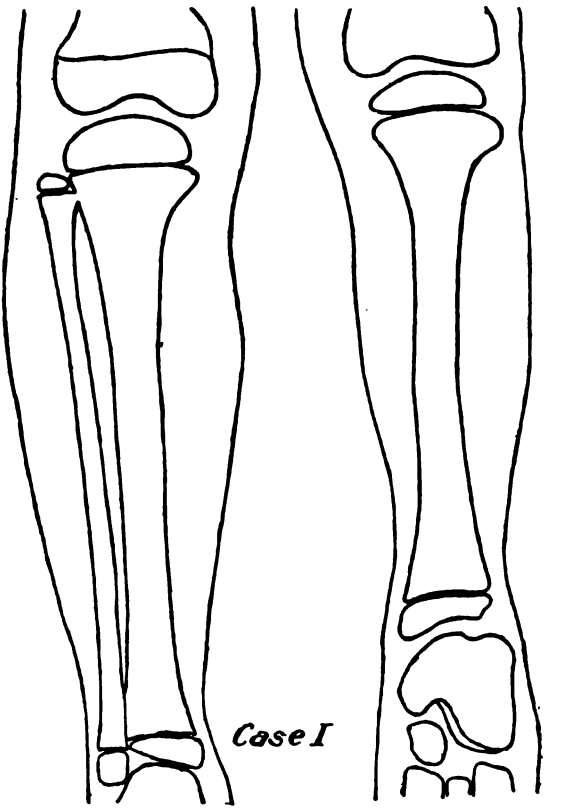
in the family. The deformity was first noticed when the child began to walk. The limp then noticed has rather increased with his growth, though the disability has never been extreme. The boy is now robust, and, except for the left leg, normally formed. This leg shows marked shortening, the tibia shows a bend forward, and the foot, which has but four toes, is in marked valgus. The

FIG. 2.



total shortening is two and one-half inches, one-half inch of which is due to shortening of the femur. The girth of the left thigh is two inches less than on the right side. The patella is distinctly smaller than on the sound side. The circumference of the calf is one and one-quarter inches less on the left. No trace of the fibula is to be felt. At the middle part of the tibia there is a distinct bend

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forward. Over the most salient point of this bend is a faint scar-like line, something over one-half inch in length.

The foot shows no equinus, and the whole sole is used in walking. The foot is, however, markedly everted when weight is borne on it, the inner malleolus coming much nearer the ground than in the sound foot. There are but four toes, the great toe being considerably larger in all dimensions than that of the other foot; the other toes are of normal size and shape.

Examination with the fluoroscope and x-ray photographs showed no trace of the fibula. There is defect of one toe and of the corresponding metatarsal bone. The astragalus, calcis, and probably the cuboid are represented by a fused mass of bone of irregular shape; the scaphoid and the three cuneiforms are normal, at least in position.

The boy has as a result of the shortening a marked scoliosis with rotation—the dorsal convexity to the left; this disappears on lying down. He has a marked limp, but never had any pain, and is active. The boy left the institution shortly after being seen, and has never had other treatment than a high sole.

Case II. E. F., a girl of eight years, was also at the Marcella Street Home. The deformity in this case was very similar to that in Case I., but the disability greater. This child also is, save for the affected leg, normally formed, and though small, yet of strong frame.

The shortening in this case is two and five-eighths inches for the lower leg, one-half inch for the thigh. The whole limb is evidently atrophied; the difference in girth of the two thighs being three-quarters of an inch, of the calves two inches. The femur at its lower end is obviously less in width; the patella is notably less in size.

There is an obvious defect of the fibula. Only in its lower quarter is anything to be made out, and there is no trace of an external malleolus. The outer edge of the upper joint surface is palpable during flexion and extension, where the external malleolus should be. The tibia, shortened but not thickened, is definitely bent, though at a very obtuse angle. The apex of this angle is about the junction of the middle and lower thirds of the tibia and

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is directed forward and slightly inward. There is no sign of thickening about the angle.

Over the most salient point of this bend is a longitudinal scar-like depression, about three-eighths of an inch in length, which is more adherent to the bone than is the surrounding skin.

The foot is held in equinus by contraction of the calf muscles, and is used in strong plantar flexion, showing considerable pronation when bearing weight. The peronei seem to be little, if at all, contracted. The foot itself, narrower than its fellow and three-quarters of an inch shorter, is of sufficiently normal shape save for the lack of one metatarsal bone with its toe. The remaining toes are normal in shape, in size about the same as those of the other foot.

All voluntary and passive movements of the hip, knee, and ankle, and of the foot are normally carried out, except as limited by the shortening of the calf muscles. There is no paresis and no essential muscles are absent. The reflexes are normal.

There is a scoliosis due to the shortening, which wholly disappears in the prone position.

The presence of a large hairy mole on the thigh of the lame side is of interest, though probably of no significance.

The x-ray examination showed a normal right leg; on the left the following anomalies: A considerable decrease in width of the lower epiphysis of the femur; no marked change in its vertical thickness. The upper epiphysis of the tibia likewise of normal thickness, but much less in width (shows in the photograph as three-eighths of an inch less). The intercondylar groove of the femur is much less marked than on the sound side. Below the head the tibia approaches the normal thickness, and the shafts of the two tibiæ are about equally thick. The lower tibial epiphysis is narrower (one and one-sixteenth *vs.* one and seven-sixteenths inches) and considerably thinner vertically; the epiphyseal line grows somewhat indistinct toward the outer side. The angle in the tibia does not show in the front view. Viewing the leg from the side with the fluoroscope one sees a definite but very obtuse angle in the bone without any thickening of the shaft.

The fibula measures but three-fifths as much in length as the sound one; the shaft is little more than half the normal diameter.

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The upper epiphysis does not show on the plate, though the conformation of the end of the bone suggests its presence unossified. The lower epiphysis is present, of two-thirds the normal size, but so shifted upward that its tip comes opposite the epiphyseal line of the tibia; the external malleolus, therefore, does not enter into the articulation at the ankle.

FIG. 8.

In the tarsus is to be seen a mass evidently representing fused astragalus and calcis, and probably scaphoid as well. The cuboid and the three cuneiforms are distinct. The first and second metatarsals have the normal articulation; the third articulates with the outer cuneiform and with the cuboid, the fourth with the cuboid alone. The metatarsals and phalanges are, save for the defect of one toe and metatarsal, entirely normal.

Before being seen by us the child had had no treatment. With a view largely to correction of the scoliosis a tenotomy of the tendo Achillis was done, and a boot with a high sole applied. This reduced the scoliosis to a minimum, but the valgus position of the foot was rather aggravated. Accordingly a sole-support with double uprights was so arranged, by raising the heel end of the boot, as to

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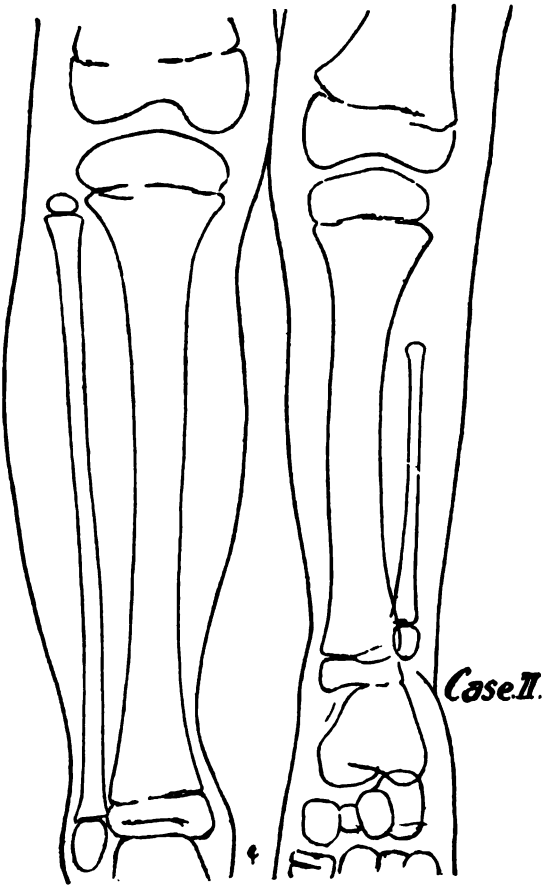
leave the foot in moderate plantar flexion. This apparatus, in connection with a high-soled boot, has somewhat improved the gait.

FIG. 4.



CASE III. J. R., a boy of two years, seen through the kindness of Dr. E. G. Brackett, is an out-patient at the Children's Hospital. At birth it was noticed that the child had but three toes on the right foot, and that the foot was held in a queer position, which, from the description of the parents, must have been a calcaneo-valgus. Under no other treatment than the mother's manipulations, this "queer" position has almost entirely disappeared.

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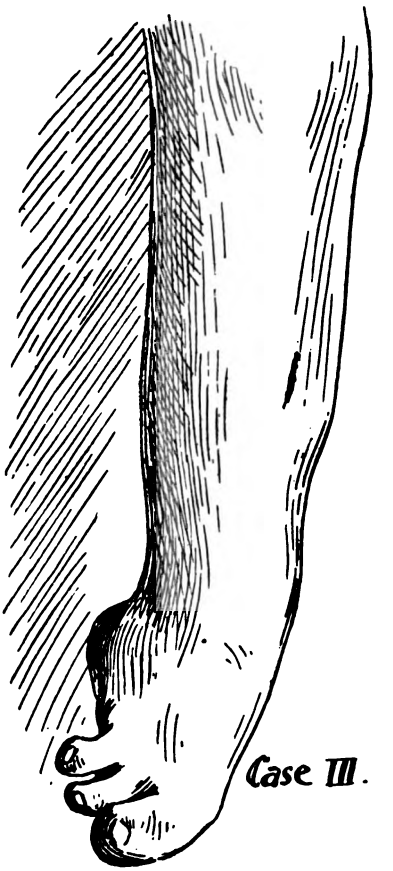
At present the right leg is one and one-half inch shorter than the left, all of this shortening apparently in the lower leg. The thigh and calf are both smaller than on the normal side, and shaft and condyles of the femur feel distinctly more slender than on the left. The patella is not much over one-third the normal size.

FIG. 5.



The tibia shows a bowing forward a little below the middle, with very little deviation, however, in the long axis of the bone; over and about the bend the tissues seem somewhat thickened, but there is apparently no thickening of the bone; over the bend in the front is a faint scar-like line half an inch in length.

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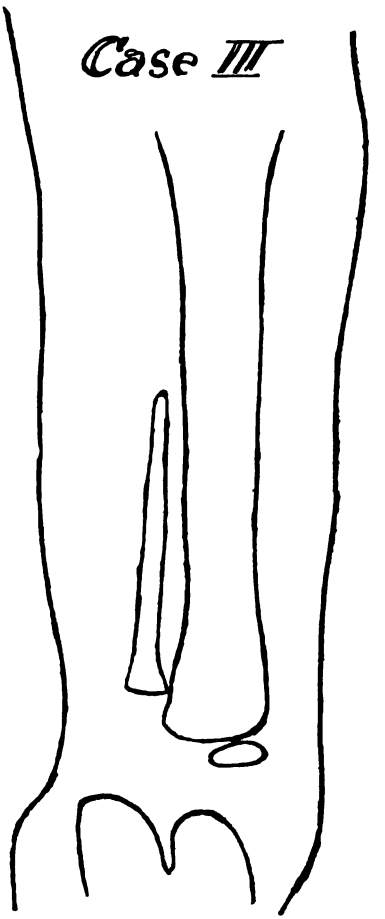
No fibula could be felt, and the prominence of the external malleolus was wholly wanting. The radiograph, however, shows a rudimentary fibula, about two inches in length, the lower end of which is nearly one-half inch above the lower epiphyseal line of the tibia. Nothing is to be seen of either epiphysis, but from the

FIG. 6.



shape of the lower end of the fibula it seems probable that the lower epiphysis exists, though it probably, as in the last case, does not reach the ankle-joint. The upper end of the fibula, unlike that

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in Case II., tapers off gradually, and there is no reason to suppose the presence of an epiphysis there.

The foot in this case has but three toes, sufficiently normal in size and shape, and is one and one-half inch shorter and much narrower than the left. It is held in very slight equinus, while the valgus deformity is extreme. The foot can be brought up to nearly a right angle with the leg, but correction of the valgus is only partly possible. This is evidently due to contraction of the peronei, which are drawn tense long before the normal position can be attained.

Radiographs show an apparent fusion of the talus and calcis. The cuboid is much smaller than normal; the scaphoid and the cuneiforms somewhat small. Two metatarsals, with the corresponding phalanges, are wanting.

The boy, who has walked for eight or ten months, has an extreme limp, and is not active, but has no pain. He is now wearing a valgus shoe with a T-strap.

In neither of the two cases (I. and III.) in which a complete history was obtainable was there any account of hereditary deformity, of prenatal trauma, or of abnormal labor.

Many cases of this sort have been reported, and there has been much discussion as to their etiology, with a number of theories to account for the relatively constant association of these apparently unrelated deformities. Most of the earlier observers (Gurlt, Brodhurst, Swan, and others) and some of the later ones (as Brinton, Ithen, Braun, and Busachi) have believed the bend in the tibia a result of intra-uterine fracture, while the "scar" was supposed to indicate compound fracture. The accepted etiology was either external trauma or excessive muscular contraction on the part of the fœtus. These observers had no clear theory as to the cause of the defect of toes and fibula.

Little accounted for the fracture, which he accepted as proximate cause, by supposing an overaction of muscles due to some vice of innervation, which, of course, explains nothing.

Broca supposed a defect of development with fracture from muscular action.

Honel believed there was some underlying change in the bone structure.

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Adams believed the condition not an absence of the fibula, but a fusion of tibia and fibula.

Pressure from twin pregnancy and compression by the cord have been made to serve as causes, but with no support in fact.

Blasius, noting the lack of growth of the limb in later life, found this hard to reconcile with the theory of trauma, but advanced no other theory.

Chance supposed compression in abnormal position (against the other leg) by the cord to be the cause; the scar as a result of decubitus.

Fricke, noting that the fœtus in the fifth to the sixth week shows a bend of the tibia, and assuming the factor in the straightening to be the growth of the fibula, was inclined to assume, in cases with fibular defect, a mere persistence or exaggeration of this fœtal condition.

Brinton, writing in 1884, considered the trauma primary, and tried to explain the associated defects as in some vague way secondary to it.

Ithen in 1885, Braun in 1886, still held to trauma, Braun holding the fibular defect to be a predisposing cause of the fracture in that it weakened the leg. The defect he did not explain. Recognizing the uncertainty whether the dimple over the angle was or was not true scar, he suggested the possibility of decubitus as a cause.

Temesvary, six years later, reiterated these views; and the theory now usually accepted, that of amniotic pressure and adhesions, though suggested by Dareste in 1882, seems to have been overlooked until 1892, when Sperling, in a masterly paper, reviewed the whole subject, and challenged all evidence supposed to prove that these so-called intra-uterine fractures are fractures at all, and pointing out the possible explanation of their causation by abnormalities of the amnion. His arguments, in brief, were: A fracture in utero by direct or indirect violence would be hard to produce, the fœtus being suspended in amniotic fluid and protected by uterine and abdominal walls.

Violence sufficient to produce such a fracture would, usually at least, produce miscarriage.

If uterine pressure were the cause of fracture we should have

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fractures occurring with some frequency intrapartum, when the intra-uterine pressure is greatest; in fact, however, such intrapartum fractures occur only at or near full term, and as a result not of intra-uterine pressure alone, but of the counter pressure of the bony pelvis as well.

Callus is practically never found in the cases belonging to the class under discussion.

The presence of the so-called scar is not valuable evidence of compound fracture; it is not even proved that it is a scar.

The defects of fibula and toes, so frequently associated with the tibial bend, point to an origin as early as the second month of fœtal life, for at this time the parts are laid down and defects in the true sense cannot arise later.

These defects cannot be, so far as we can see, either cause or result of the so-called fracture. Hence the association points to a common cause for both.

It seems likely that both are due to pressure and pull of the abnormal amnion and its adhesions; the more likely, inasmuch as this seems to be the cause of other similar deformities.

Haudek, in an extensive article published in 1896, accepts Sperling's conclusions, and adds to the evidence the report of the microscopic examination of one of these so-called scars which he had excised. It showed no interruption of the skin layers and only such fibrous and atrophic changes as could best be explained as the result of pressure; in short, could not be called true scar. He also called attention to the fact that defects of the radius, which in early fœtal life lies exposed in supination, are, with the associated defect of thumb and fingers, the not infrequent counterpart of defect of the similarly exposed fibula.

Kirmisson notes in this connection the scar-like marks over the bowed ulna, which occurs in some of these cases of radial defect.

Nélaton, Kirmisson, Hoffa, Walsham and Hughes, and very recently Nasse, in the *Deutsche Chirurgie*, accept these views in general, and of late other theories have been largely given up.

Delanglade, in a case report which appeared recently, accepts the amniotic theory, but is inclined to lay more stress on the narrowness of the amnion than on the action of adhesions, a reservation tacitly made by several others of the above list.

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In considering this list of theories we find several that need not detain us. The theory of changes in bone texture lacks all evidence. That the pressure of twin pregnancies is not the cause is evident on inspection of the published list of cases. The defect is not a fusion of tibia and fibula, for, as Gould has pointed out, the interosseous membrane is present. Moreover, where the fibula is defective in part only, the rudiment occupies its normal position. Fricke's theory, of persistence of the fœtal bend, does not account for the usual direction of the bend, forward and inward instead of forward and outward, and presupposes, without explaining, the absence of the fibula.

The theory of nerve changes as a cause lacks evidence and is not in accord with recent work which tends to show that growth in utero is independent of the nervous system (Schaper).

There remain only the theory of damage to or absence of original cell elements, that of fracture, and that of amniotic changes. The arguments of Sperling and Haudek seem to suffice to dispose of the fracture theory. It is conceivable, and cannot be disproved, that the defect may be one of development *per se;* but the theory of development by "rays" lacks proof that such rays exist, and at best cannot explain the undoubted cases of defect of the fibula or radius without defects of foot or hand. On any other theory of defect due to absence or faulty arrangement of original cell-groups, it is hard to see how to explain the relative constancy of type and the limited extent of the deformity. Nor can such a theory explain the presence of the tibial bend or the so-called scar.

The amniotic theory, however, seems to explain all the lesions pretty clearly. We cannot but accept it as at least the most plausible theory yet advanced. The origin of the typical deformity would be, then, as follows: Between the fifth and eighth week pressure of a too-tightly fitting amnion interferes with the development of the exposed fibula and the outer toe or toes of the exposed foot. Lack of space determines the bend of the growing tibia; the adhesion which produces the so-called scar is a result of contact and adhesion of the most salient points of the tibia with the enveloping wall. The persistent lack of growth of the whole limb is probably a result of deficiency in vessels and nerves due to the early pressure, as well as of disuse.

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As to the frequency of this deformity, it is not so rare as would be supposed from some very short lists recently published. Haudek collected, with his own case, 103 in all, and we have found others to bring the list up to 128, including the cases here reported:

Cases	103	Haudek's list. Ztschr. f. Orth. Chir., 1896, Bd. iv. p. 326.
"	6	Kirmisson (besides two cases included by Haudek) Traité des mal. chir. d'origin congen., Paris, 1896. Revue de Chirurgie, 1897, p. 524.
Case	1	Walsham and Hughes. Deformity of Human Foot.
Cases	3	Steele. Trans. Amer. Orthopedic Association, 1896, vol. ix. p. 175.
Case	1	Freer. Trans. Brit. Orthopedic Society, Birmingham, 1896.
"	1	Humphrey. On the Skeleton. (Cited by Gould. Trans. Path. Soc., vol. xxxii. p. 158.)
"	1	Proudfoot. New York Journ. of Med., 1846. (Cited by Brinton. Trans. Amer. Surg. Association, 1884, vol. ii. p. 425.)
"	1	Langton. St. Bartholomew's Hospital Report, 1879, vol. xv. p. 272.
"	1	Kaufmann. (Cited by Braun. Arch. f. klin. Chir., Bd. xxxiv., 1886.)
"	1	Delanglade. Rev. des mal. de l'enfance, April, 1898.
"	1	Tyrie. Journ. Anat. and Phys., 1894, vol. xxviii. p. 911.
"	1	McKenzie. New York Medical Journal, 1897, vol. lxv. p. 241.
"	1	Morestin. Rev. des mal. de l'enfance, April, 1898.
"	1	Rose. Centlbl. f. Chirurgie, 1897, No. 12, p. 357.
"	1	Tubby. Deformities, 1896, p. 359.
"	1	Whitman. Rev. d'Orthopédie, 1898, t. ix. p. 86.
Cases	3	Cases reported here.
Total,	128	

Moreover, Nasse speaks of having seen this defect repeatedly in Von Bergmann's clinic, and H. L. Taylor speaks of having seen eight or ten cases, though neither give details. A reference to a report by Burmeister[1] has not been verified, as it was not accessible to us.

As to the details of cases reported and the varieties occurring, the following notes are presented.

The fibular defect is noted as total in 72 cases.

A fibula of not over half the normal length with both epiphyses present, one or both small, is noted three times. In Volkmann's dissections the upper epiphysis of the fibula was prolonged upward by a fibrous band. This band may in part replace a fibula which has no upper epiphysis (Braun), or may replace the whole fibula (Gould, Wagstaffe). Where an epiphysis is present it may show lack of ossification; this is probably the condition in Case II. of our series. Where the lower epiphysis is present it may lie higher up than normal, and not serve as a part of the ankle-joint. This is shown by Bidder's dissections and by the radiograph of Case II.

[1] Arbeiten aus dem Gebiete des Geburtsh. u. Gynäk. von Carl Ruger, Berlin, 1896, S. 215.

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as well. Probably this condition may often obtain, for in the absence of radiographs, where no external malleolus is felt, it is very hard to say whether a rudimentary fibula may not be present.

A bend or angle of the tibia, directed forward and usually slightly inward, usually accompanied by the so-called scar, is noted in sixty-seven of the published cases. The acuteness of the angle varies widely. There may be thickening of the tibia, or its head and shaft may both be slenderer than normal. The shortening of the shaft is present to a greater degree than can be accounted for by the bend, and may be marked. As to the lower end of the bone, it may show no obvious change or may show a knobby internal malleolus and an oblique surface for the ankle articulation. This latter condition is the classical one in the case of "Volkmann's Congenital Dislocation of the Ankle." It is a question, however, whether these cases do not belong in a separate class. The original cases described by Volkmann, Kraske, and Bidder, though they had defective fibulæ, had no defective toes, and all occurred in members of one family, seven out of seventeen of whom had the deformity. This hereditary character does not accord with either the facts or the theory of cases of fibula defect in general. For these few cases, however, the dissections reported show a definite obliquity of the ankle-joints primary and the cause of the extreme deviation of the foot. Bidder found in one case that the lower epiphysis of the tibia, 1.2 cm. thick at the inner side, fell away to 2 mm. at the outer.

We have no evidence of the existence of such obliquity in the majority of cases, but it is very probable that it exists to some extent. The radiograph in Case I. shows some obliquity, and that of Case III. suggests it.

Defect of one or more toes associated with the fibular defect is noted expressly in sixty-seven cases. In one case (Kirmisson), on the other hand, there were seven toes. Apart from one case (Otto), where the great toe is said to have been wanting, the defect seems always to have affected the outer toes. Several cases are reported where all save the hallux were lacking. There is often some disproportion in the size of the toes. Webbing, especially between the second and third, is frequent. In some cases there is associated defect of toes on the other foot (without fibular defect).

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The metatarsals corresponding to the missing toes are uniformly absent.

Some of the tarsal bones may be lacking, or more often there is fusion of several of them; the calcis, talus, scaphoid, and cuboid, or some of these are specially likely to fuse. There seems to be no regular type of deformity here.

The foot is in equinus (usually with contracture), usually in equino-valgus of varying degree. In five cases, however, varus or equino-varus is reported. In one of our cases the position in the beginning seems to have been calcaneo-valgus. The contracture of the tendo Achillis accompanying the equinus is not entirely owing to the disuse of dorsal flexion in a short leg, for it may, as in a case of Bidder's, occur where the deformity is bilateral and equal.

In twenty-one cases the patella is noted as of less than normal size. It may be wanting, or at least not distinguishable clinically.

A lack of development of the whole limb, femur as well as tibia, is usual, varying widely in degree. Whether this may be in part, as Nasse seems to think, due to the atrophy of disuse, or from congenital deficiency of vessels and nerves, is hard to say. The shortening is progressive, and its increase as the child grows is a very important factor in determining the disability.

Braun reports two cases of sixteen and seventeen years, with a shortening of 7 and 8 cm. respectively, the femur being responsible for 2 cm. in each case.

Blasius found in one case at ten years two inches shortening; in another at nine years, two and one-half inches.

Kirmisson had a case with 12 cm. shortening at two years, with atrophy of the whole extremity.

Schnelle reported a case with three inches shortening at three years, five inches at ten years, nine inches at twenty-nine years.

Kaufmann found the increase of shortening between two and one-half and six and one-half years of age to be 2 cm. in one case.

Kemke, in a case seen at birth, found the tibia 1.5 cm. short; at one and a quarter years the shortening was 2.5 cm.

The deformities associated with fibular defect have been most various, including harelip, skull defects, visceral anomalies, etc.; but, as would be expected from the accepted theory, defects of the foot as a whole, of the femur, of the whole upper extremity, or

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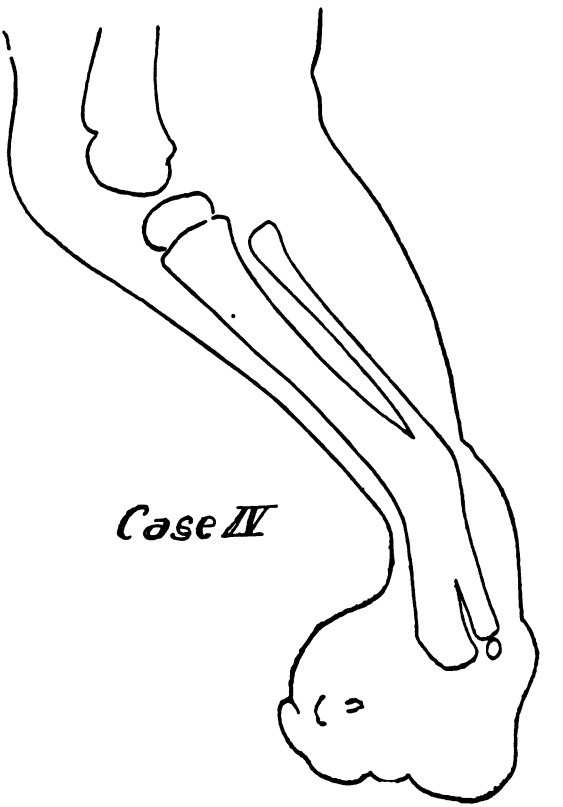
especially of the ulna or radius and of the fingers, are most common.

Before leaving this part of the subject it may be well to call attention to some deformities of the leg which seem to be of similar origin with the fibular defect, those where some constriction is apparently the cause.

CASE IV., aged four years, an unreported case seen by the kindness of Dr. J. E. Goldthwait, has a shortened and deformed leg and

FIG. 7.



foot, shown in the accompanying figure. The x-ray shows no defect of tibia or fibula, but at the point of constriction the bones lie in contact and seem to be fused. At this point there is also a bend in

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both bones, forming an angle open forward. The site of constriction is marked by a deep sulcus, without scar, encircling the leg.

The x-ray shows no ossification in the foot; manipulation shows the presence of some bones apparently fused, in part at least. Anterior to the tarsus the foot is pulpy, and there must be extensive bony

FIG. 8.

defects. The total shortening from knee to heel is two and one-quarter inches, from knee to ankle one and one-half inches. The deformed foot measures but two and three-eighths inches in length, the normal five inches.

A case of deformity strikingly similar to this is reported by Ridlon,[1] in which the circular constriction about the ankle was associated with other similar constriction rings, with spontaneous amputation of fingers, etc.

Still another case is reported by Steele,[2] where a depression just above the ankle, as from a cord, coexisted with defect of fibula and toes, and bend, with so-called scar, of tibia.

These cases, taken together, make it seem possible that this class of cases may also be due, not to strangulation by the cord, but, like those we have been considering, to abnormalities of the amnion, although the mechanism is not clear. Chance[3] cites similar cases which he explains as results of amniotic adhesions.

The conditions to be considered in treatment are: (*a*) The total shortening; (*b*) the abnormal axis of the lower part of the tibia; (*c*) the equinus: the shortened calf muscles; (*d*) the valgus deformity.

[1] Ridlon: Trans. Amer. Orth. Association, 1896, vol. ix. p. 179.
[2] Steele: Ibid., p. 175.
[3] Chance: Bodily Deformities. London, 1862, p. 135.

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These are present in varying proportion in different cases. There can, therefore, be no routine treatment. The total shortening may be so great, especially if the other deformities of the limb are also extreme, that amputation will be the only resort. This has been repeatedly performed.

So far as the shortening is due to the bend in the tibia it is amenable to treatment by osteotomy or osteoclasia. Brinton in one case reduced the shortening in this way from two and one-eighth to one and one-half inches, and Rose reports the successful correction by osteotomy of a right-angled bend in the tibia in one of these cases.

Tenotomy of the tendo Achillis has usually been necessary as an accessory to this as to other operations on these cases. It has been performed also as the only measure for relief, but in this way is not productive of much result. In some cases a wedge osteotomy has been performed; in one case (Langton) followed by non-union. There have been other unsatisfactory results after osteotomy, but there seems no reason, if the operation is carefully done with a tenotomy, why the tibia cannot be accurately straightened in this way, as has been done by Rose, Brinton, Kirmisson, and others, nor why there should be a return of the deformity, as has occurred (Küster).

As to avoidance, so far as may be, of the increase of shortening with the growth of the child, Nasse lays stress on early use of the limb, with proper support, to avoid atrophy from disuse.

The equinus may always be remedied by tenotomy of the tendo Achillis, which has so often been performed. The important fact to bear in mind in this connection is that the equinus is in large measure an attempt at compensation of the total shortening, and if the ankle can be supported in the equinus position, it is hard to see what is to be gained by the tenotomy, unless, indeed, the shortening is so little that a moderately high sole will fully compensate.

The most difficult problem to treat has usually been the valgus deformity. This is not, at least in the majority of cases, a valgus of pronation and flattening simply, but rather a tipping outward of the whole foot, including the astragalus, which has no external malleolus to hold it in place. Moore[1] has recently reported cases of valgus resulting from the removal of the fibula for disease,

[1] Moore: Annals of Surgery, 1896, xxiv. p. 634.

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which illustrate this mode of production of the deformity. In some cases, at least, obliquity of the lower surface of the tibia determines the valgus; in others there is apparently no such obliquity. The tipping outward of the foot must also be favored by the irregularity of the articular surface of the astragalus in these cases, as also by the fact that the bones of the tarsus are often partly fused, and hence must have less mobility. These facts are probably the explanation of many failures in the treatment by use of the high sole after tenotomy of the Achillis, and are to be carefully considered in outlining any treatment. In a proportion of cases (as in Case III.) there is contraction of the peronei, as well as of the calf muscles, which necessarily prevents correction of the valgus until tenotomy is done. This section of the peroneal tendons has been performed (Brinton, Nélaton, Walsham, Kirmisson) with good success.

In cases where there was obliquity of the ankle-joint a wedge osteotomy above the ankle has been performed by Riedinger and by Walsham with good result. Volkmann in one such case took a wedge out including both articular surfaces at the ankle, securing correction of the valgus and an anchylosed joint; the result was fair.

Simple resection of the ankle-joint has been done in a number of cases. One of the most successful is a recent case by Rose, where the lost ankle motion was compensated after operation by increased mobility in Lisfranc's joint. If this anchylosis be so effected that the foot remains in plantar flexion (Braun), this will lessen the needed height of sole. Where the deformity is bilateral this is, of course, no point, but in other cases it seems desirable. The Wladimiroff-Miculicz resection, suggested by Kemke for such cases, but not carried out, would have no advantages. In two instances (Rincheval, Nasse) Bardenhauer's operation, the splitting of the tibia and the insertion of the talus in the split, has been carried out. Nasse secured anchylosis in equinus thereby. In both cases the result seems to have been satisfactory. In cases where the rudiment of the fibula, as shown by the x-ray, is of some size but situated higher up than normal, it seems possible that an operation aiming to slide it down and fix it to the tibia as an external malleolus might be worth considering. It has apparently never been done.

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Attempts to remedy the defect by orthopedic apparatus have on the whole been about as satisfactory as the operative cases. The worth of operative procedures must vary with the cases, but in most cases, and especially when the limb as a whole is markedly atrophic, not much is to be expected. In a recent discussion by Kirmisson, Nélaton, and others, it came out clearly enough that the results attained immediately after operation were not conclusive as to the end result. Bidder gives plates of two cases, one where Volkmann did ankle resection, the other one of Küster's, where an osteotomy had been done; these end results are not encouraging. Probably in any case, even if operated on, an apparatus of some sort must be worn to prevent recurrence or the rise of some new deformity. The limb is primarily defective as well as deformed, and correction of the deformity if complete does not solve the whole problem. Probably unless osteotomy promises some considerable gain in length or in the position of the foot, or unless peroneal contracture interferes with the reduction of the valgus, no operation, not even a tenotomy, will usually be worth while. If a valgus shoe, sloped to fit the equinus, with a high sole and with irons extending up the leg, can be satisfactorily fitted, there seems no reason for tenotomy of the tendo Achillis.

To sum up, in so far as one may generalize where cases so vary, osteotomy is to be performed not merely because the deformity exists but for definite indications; tenotomy only to help reduction of the valgus, or as an adjunct to osteotomy; amputation only in cases utterly unfit for other treatment.

Treatment of all ordinary cases by apparatus to support the ankle and prevent valgus—a high sole to supplement the equinus in equalizing the shortening. These seem to be the general lines of treatment. The treatment seems to be unsatisfactory at best, and, as always in such cases, operation is to be avoided unless there is some clear gain in view.

Appended is a partial bibliography; other references, especially to older and less accessible publications, with detailed citations of a large number of cases, will be found in Haudek's article.

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DEFORMITIES OF THE CHEST IN RICKETS.

By J. S. STONE, M.D.,
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Aside from those malformations of the chest secondary to Pott's disease and scoliosis, there are, according to the classification of Redard, three types of deformity. These are: first, the "pigeon breast;" second, the "cobbler's chest;" and, third, the "funnel chest." The cobbler's chest presents a marked retraction of the ensiform, while in the funnel chest the tip of the ensiform may point outward, the depression being greatest at a point near the junction of the gladiolus and ensiform. To these may be added an extremely rare deformity, the "gutter chest," in which the costal cartilages dip in sharply to the sternum.

In the great majority of cases of rickets there is a pigeon breast, or there are to be seen those deformities which, if more pronounced, would produce a pigeon breast. It is difficult to draw a dividing line between the cobbler's chest and the pigeon breast in many cases. The funnel chest differs absolutely from the pigeon breast, is very frequently found entirely independent of rickets, and is probably never due to rickets alone.

In the normal infant at birth the ratio of the depth to the width of the thorax is as two to three, while in the adult it is as one to two and a half, or one to three. In other words, in the infant the chest is relatively only about half as wide as in the adult. This change in the shape of the chest begins at an early age, and goes on coincidently with the growth in the breadth of the shoulder girdle and the increasing use of the arms.

In normal respiration the intercostals, the scaleni, and the levatores costarum take part. The serratus magnus and the pectorals play a part in labored breathing. Through their attachments to the

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ribs the latter muscles tend to prevent any sinking in of the chest-wall. They leave directly exposed to atmospheric pressure the sixth, seventh, and eighth ribs near the junction with the costal cartilages. Anteriorly the upper ribs have a better muscular protection than the lower. Posteriorly the thorax is protected thoroughly by the scapula and the deep layers of muscles.

According to Veirordt, the softening of the ribs in rickets is greatest in the lower five, and the greatest softening occurs in the cartilages. Furthermore, the cartilages in the four middle ribs are the longest.

Thus, in cases of rickets, at a point immediately below the nipples three factors combine to allow a yielding to the atmospheric pressure. These factors are the lack of muscular protection, the greater softening of the ribs, and the greater length of the cartilages. In practically every case of rickets there is a greater or less depression of the chest at this point. It may be marked or may be so slight as to be of no particular significance, but it is almost invariably to be found.

In the more severe cases the sinking of the chest-wall is more extensive, extending upward along the junction of the ribs and cartilages or toward the axillæ, or outward in the form of a transverse groove, known as Harrison's sulcus, and often erroneously thought to be due to the action of the diaphragm. The ensiform and the cartilages immediately adjacent are often, it is true, retracted by the diaphragm, but the retraction at this point is often seen entirely independent of rickets. Just as in Pott's disease there is often a narrowing of the chest and a retraction about the ensiform, so the general rhachitic kyphosis tends to cause a similar retraction. In cases where cough has been frequent, and in cases where the spine is widely separated from the sternum, the retraction of the ensiform is most marked.

On either side of the median line, however, the transverse groove of rickets is above the lower border of the pleura. The retraction occurs along the lower part of the pleural cavity. The costal and diaphragmatic pleuræ are approximated, the lower border of the lung being retracted or collapsed. In the accompanying photograph of a child in whom this transverse sulcus is moderately developed there is seen marked upon the chest-wall the lower border of the

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pleura and the pericardium, which is, of course, somewhat above the attachment of the diaphragm. The transverse groove at the sides is slightly but distinctly above the pleural border. If a child is ob-

FIG. 1.

The lower border of pleura and pericardium is marked. The transverse sulcus in the median line is along the diaphragm, on the sides distinctly above it.

served when sobbing, the action of the diaphragm is brought out plainly. There appears below the pleural cavity, close to the sides

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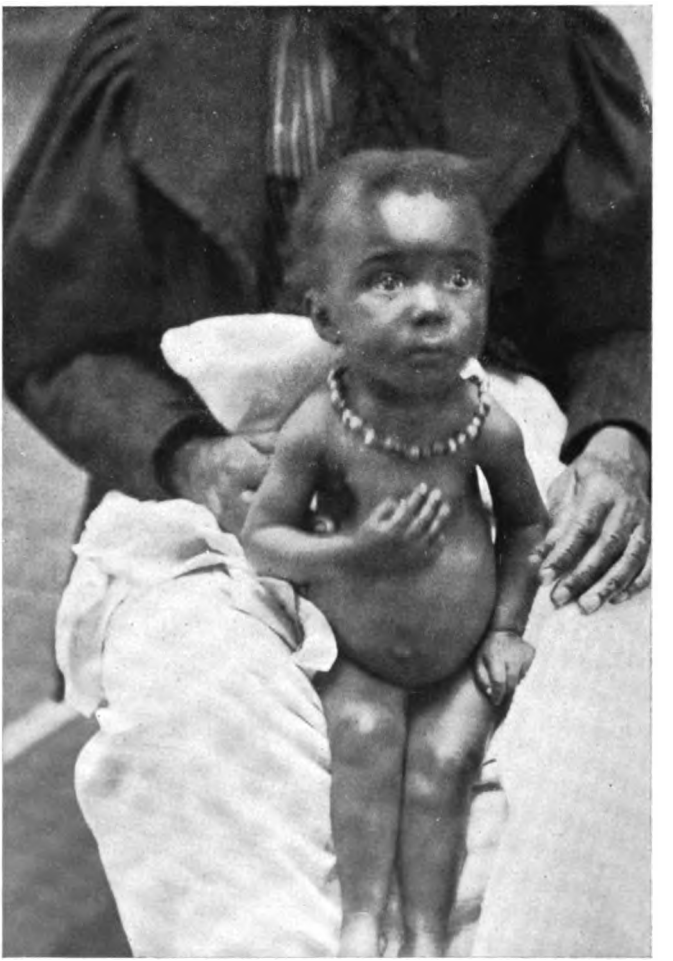
of the ribs and their cartilages, a sharply defined line of retraction at a slight angle with the groove higher up.

FIG. 2.



Flattening of the sides of the chest.

In explanation of the fact that the diaphragm does not retract the lower ribs, one must look primarily to the distended abdomen of rickets. The diaphragm, together with the anterior and latera

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belly-walls, may be considered as making, together with the kyphotic lumbar spine, a great dome, to the outside of which are fastened the ribs. While the diaphragm tends to pull in the lower ribs, the abdominal muscles tend to draw them out, pulling, as they do, over the abdominal viscera. The very common increase in the size of the liver and spleen in rickets and the very general intestinal distention help to keep the lower ribs from sinking. In animals the removal of the abdominal viscera allows a sinking of the lower ribs along the attachment of the diaphragm.

The flattening of the sides of the chest is rather less common than the formation of the transverse groove. It occurs in about a quarter of the cases, and is found most frequently in the more marked grade of rickets. In addition to the atmospheric pressure, there are certain causes which tend to produce this deformity. Lack of growth of the ribs is a factor, of how much importance it is difficult to say. Lack of growth of the shoulder girdle and increase in the curves of the clavicle is a factor of some importance. From this cause the chest lacks part of its normal support. Repeated manual pressure against the sides of the chest in lifting may be the cause in some cases. Pressure of the arms against the sides, on which some stress is often laid, is of no consequence, except possibly during sleep, when the child lies upon an arm. It is evident that in most cases the arm cannot touch the side of the chest because of the abdominal distention.

A marked sinking in along the lines of the rosary is less common than the flattening toward the axillæ, is usually found in cases with a well-marked rosary, and appears to depend on an extreme softening just at the junction of the ribs and cartilages. Round shoulders are practically an integral part of a general kyphosis, and are of great importance in producing flattening of the upper chest, because the ribs lack their proper muscular support.

These four elements—the submammary flattening, the formation of the transverse sulcus, the flattening of the sides of the chest, and the flattening of the upper anterior chest—enter into the formation of the pigeon breast, which is simply the final outcome of a process of which the submammary flattening is the first stage. No dividing line can be drawn to separate one deformity from another. The difference is merely one of degree.

According to Vierordt, in rickets the softening of the ribs occurs

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later than the changes in the skull and earlier than the changes in the extremities, and, considering the age at which rickets usually

FIG. 8.

Retraction along the junction of ribs and cartilages.

begins, he thinks that the thoracic changes are greatest in the early part of the second year, at about the age of fifteen months. Clinical

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experience confirms these observations as to the age at which the chest deformities are usually greatest, but other factors than a difference in the time at which the different bones are affected influence the relative degree of deformity of the chest.

The most severe rhachitic cases are usually seen early in the second year, occurring generally before the child stands or walks. Thus, while mechanical influences are acting on the chest the extremities are very largely protected by the partial recumbency which nature enforces. Later, when the disease is quiescent, but the bones are not yet quite firm, the child begins to walk. With the increase in activity the respiratory muscles and the arms are more actively used; the chest deformity may diminish, while deformities of the legs may steadily increase. In the milder chronic cases in which walking may not have been delayed, while the bones of the legs have been constantly bending, there may have been but an insignificant chest deformity at any time. There is thus an absolute independence of any ratio between the amount of deformity of the extremities and that of the chest. While the degree of the bony softening tends to make the deformities of the chest and of the legs vary equally, certain other mechanical factors tend to make the two sets of deformities vary inversely.

In all descriptions of rickets it is stated that the chest deformities prevent the expansion of the lungs, thus rendering the child more liable to bronchitis and broncho-pneumonia—a cause of a large mortality. A catarrhal condition of the mucous membranes is also usually mentioned as a complication of rickets. Of late more emphasis has been placed upon the fact that the intestinal disturbances, the bronchitis, and the nasal catarrh are essential parts of the disease. Thus, while without doubt the chest deformities tend to cause disease of the lungs, the rhachitic catarrhal condition of the upper air-passages, together with the intestinal distention due to a similar catarrhal condition of the intestines, is a factor of the greatest importance in the formation of the chest deformities. The lack of normal full expansion of the lungs, the flaring of the lower ribs over the big belly, the repeated coughing during the colds so common in rickets, are all important factors in producing deformity.

Hypertrophy of the tonsils and adenoids may be an accompani-

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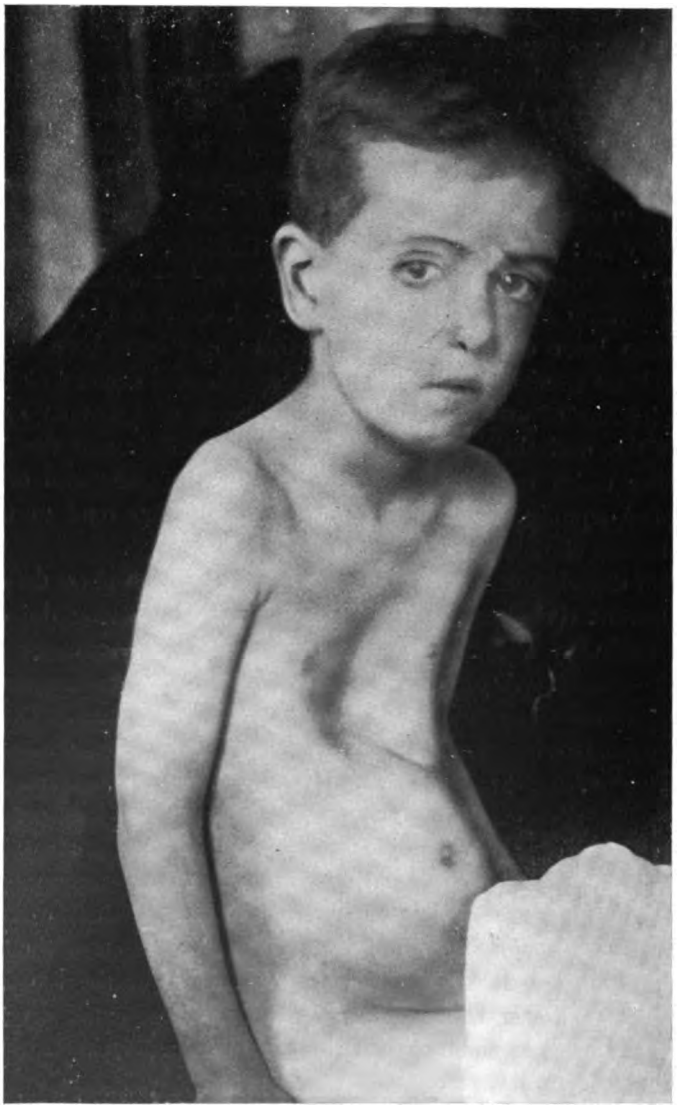
ment or sequel of rickets which may leave comparatively slight signs of deformity outside of the chest. In this way chest de-

FIG. 4.



Funnel chest, not due to rickets alone.

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formities may be attributed to adenoids which really had their origin in rickets. In those cases of adenoids where there has been no evidence of rickets the deformities of the chest may be due not so much to a direct mechanical hinderance to the entrance of air as to the secondary troubles in the bronchi and lungs.

While undoubtedly rickets tends to increase any funnel-chest deformity, it is extremely improbable that this deformity ever arises from rickets alone. So many instances of this trouble have been recorded, and they are so nearly universally accompanied by other defects, either mental or physical, that, although some are complicated by rickets, it cannot be considered the prime cause. Rhachitic chest deformity is practically always of one general type, the variations in which depend upon many circumstances.

For several reasons the prospect of recovery from rhachitic chest deformity is good. As was long ago pointed out by Shaw, and as Pye[1] has since stated, there is in rickets not only the production of deformity, but an actual arrest of bony growth. "The permanent effect upon the adult of infantile rickets must be that a dwarfing takes place which can never be recovered from, for it is due not to deformity, but to a lapsed period of growth at a most important time—a lapse which cannot be made up later, whether growth be resumed upon recovery or not." It should be recalled in this connection that the growth of children in height is mostly in the extremities, and that while from birth to a time between the fourth and fifth years the height doubles, the height below the iliac spines nearly trebles. In this same period the circumference of the chest increases only about one-half. It is obvious thus that any change in the chest must be one principally of deformity rather than one of lapse of growth as compared with the deformity of the legs. In somewhat more than a hundred rhachitic children examined this appeared very plainly. In the period between the twelfth and twenty-fourth months there was a falling off in height of about two inches as compared with Holt's tables. During this period the circumference of the head was a little increased, that of the chest a little diminished. During the next two years the height still remained about the same amount below the normal average. The

[1] Lancet, 1890, vol. ii. p. 330.

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circumference of the chest did not fall very much below the average, but at the age of two and three years in rhachitic children the chest measurements were almost identical. There was apparently a lapse in growth at this period, which, however, was insignificant as compared with that in the extremities. Thus, considering that recovery from deformity and growth are so closely associated, it is plain that there is not nearly so great a tendency for chest deformities to persist as for those of the extremities. Other types of chest deformity often increase during the period when the rhachitic deformity, which is practically always of the pigeon-breast type, is gradually diminishing. The most extreme deformities of the chest may indirectly prove fatal, another reason why marked rhachitic deformity of the chest is rare in adults.

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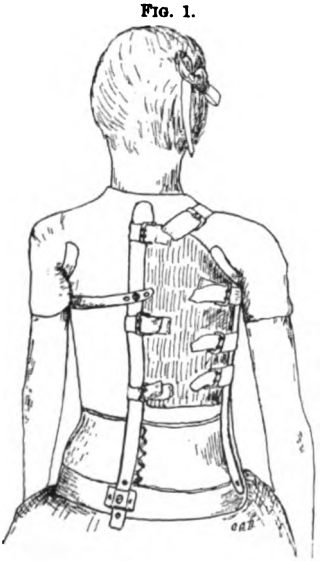
A BRACE FOR CASES OF LATERAL CURVATURE OF THE SPINE.

By GWILYM G. DAVIS, M.D,
PHILADELPHIA.

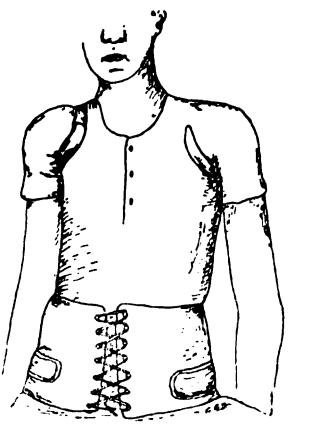
THE brace is constructed as follows: The usual waistband is used, and to it are attached three uprights, one in the middle of the back and one under each arm. (Figs. 1 and 2.) The upright under the

FIG. 1.



Brace for lateral curvature. Posterior view.

FIG. 2.



Brace for lateral curvature. Anterior view.

arm of the high side passes up in front of the shoulder. A strap passes over the high shoulder connecting the side upright to the top of the back upright. Passing under the arm and over the projecting

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posterior part of the chest is a wide band of webbing, fastened to the side and back uprights by straps and buckles. When these are pulled tight the shoulder is drawn back and pressure is made on the hump. On the opposite side the upright bears a simple crutch, the posterior end of which is fastened to the middle upright. This tends to elevate and support the depressed shoulder. Certain cases of lateral curvature absolutely demand support from some apparatus, and the form just described is the most satisfactory that I have yet been able to devise. It is exceedingly durable and lasts almost indefinitely, with slight repairs from time to time as the buckles wear out the straps. Usually, in about a year, the patient outgrows the brace and another is necessary, although I now recall two of my patients, sisters, who are still wearing their braces, in good condition fifteen months after their application. By means of a screw-driver, wrenches, and adjusting of the buckles, any change of form may be met. It may be modified at times, if so desired, to meet special indications.

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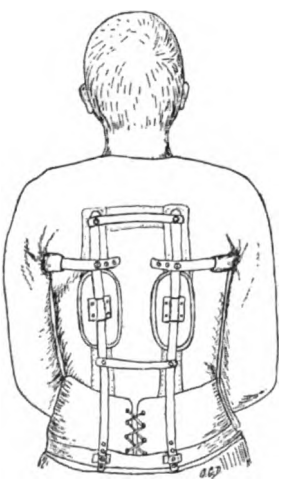
A BRACE FOR POTT'S DISEASE OF THE SPINE.

By GWILYM G. DAVIS, M.D.,
PHILADELPHIA.

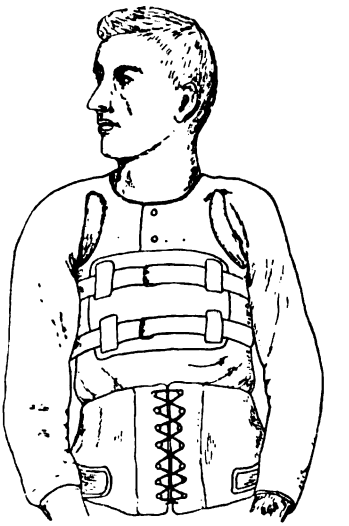
THE brace here described and figured is one which has been developed after trying various modifications, and serves as a standard. The frame, with the exception of the waistband, is made of mild forged steel; the latter is of sheet-steel. It consists of a waistband

FIG. 1.



Brace for Pott's disease. Posterior view.

FIG. 2.



Brace for Pott's disease. Anterior view.

supporting four uprights (Figs. 1 and 2). Two of these go up the back, and each carries a pad which makes pressure on the hump on each side of the spinous processes. The other two go up the sides, one under each arm, carrying a crutch or arm-piece. This crutch

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is long enough in front to curve upward in front of the shoulders. It is long enough behind to overlap the upright at the back.

In applying the brace it is first laced around the pelvis and the uprights made to conform to the back as closely as thought desirable by bending with wrenches. The side uprights, carrying the crutches, are adjusted to the proper height by loosening a screw and sliding them up or down, and then made to draw the shoulder back by fastening their back ends by means of a screw to the back uprights. The back uprights are adjustable in height by sliding them up or down in the waistband, and the pads which they carry can also be pushed up or down.

This brace was devised to facilitate fitting the apparatus to the patient, and it is practically adjustable in all directions. The efficiency and comfort of a brace depend on the accuracy of the fit, and a certain amount of adjustment is absolutely essential. It is the want of proper fitting of the apparatus to the patient that is the cause of so much dissatisfaction and inefficiency in the use of braces. By means of adjusting the arm-pieces and bending the back uprights any amount of pressure desired can be obtained.

In many cases, particularly when there is a tendency for the breast-bone to project, an apron or band is used across the front of the chest. This is fastened by webbing and buckles to the side-pieces. As in this disease the brace is used to support the weight of the body above the hump, it must do so from below. This is accomplished by having the steel in the waistband sufficiently flexible to allow of its being bent to conform to the contour of the body just above the greater trochanters. The webbing is wide enough to reach above the iliac crests, so that the weight of the brace is borne partly by the greater trochanters and partly by the iliac crests. There are no shoulder-straps. I have often seen spinal braces—with loose or inefficient waistbands—which practically hung from the shoulders, thus increasing the deformity instead of remedying it.

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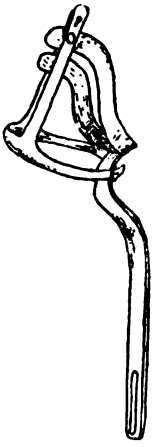
HEAD SUPPORT FOR HIGH POTT'S DISEASE.

By GWILYM G. DAVIS, M.D.,
PHILADELPHIA.

When the disease is located high up, firm fixation and support of the head are aimed at. To secure these, an apparatus devised several years ago is used. (See *University Medical Magazine*, December, 1891.) It consists of a Y-shaped support, which embraces the occiput and the sides of the head to above the ears (Fig. 1).

Fig. 1.



Head support for cervical Pott's disease.

From this a chin-piece is slung, and, if thought desirable, another band passes across the forehead. This head-support is attached to a body-brace by means of a flat rod. It is adjustable in height by means of a thumb-screw. The body-brace in these cases differs from the one already described in having only a single broad up-

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right in the back, instead of two. The upright piece of the head-rest is bent out by means of wrenches, so as not to press on the projecting cervical hump. This head-piece can also be used for torticollis. When it is desired so to use it the upper piece turns on the rivet and can be tilted to the right or left, and fixed in the desired position by means of a screw, which is inserted just below the rivet.

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TUBERCULOSIS OF BONES AND JOINTS.

(From the Sears Pathological Laboratory of the Harvard Medical School.)

By EDWARD H. NICHOLS, M.D.,
BOSTON.

THE following description of the lesions found in tubercular disease of the bones and joints is based chiefly upon a series of observations made during the past three years. Over one hundred and twenty tubercular joints, including specimens of nearly every bone and joint in the body, have been examined macroscopically and microscopically. Many of the specimens were obtained from operations or excisions performed upon diseased joints, but a very considerable number was obtained from amputations or autopsies, and in the latter cases the entire joint and the ends of all bones entering into the joint were examined. Nine specimens of Pott's disease of the spine have been examined. About two-thirds of the specimens were from children under twelve years of age, but most of the others were from tubercular joint disease in adults. The writer is indebted to the surgeons of all the general hospitals of this city, and especially to the surgeons of the Children's Hospital, for much valuable material.

The similarity between certain forms of chronic disease of the joints and "tubercular" disease of other organs was first definitely stated by Rokitansky in 1844, although his conclusions were not generally accepted. Virchow[1] stated that certain forms of chronic disease of the knee-joint were due to the development of miliary tubercles in the synovial membrane, while Volkmann[2] demonstrated the presence of actual tubercles in the joint. Volkmann's work deserves more than passing mention, on account of his accurate descrip-

[1] Virchow. Geschwülste, ii. 652.
[2] Volkmann. Krankheiten der Bewegungsorgane, Chirurgie von Pitha-Billroth, ii. 2, 1865.

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tion of the pathological process, and because of his wonderfully logical inferences in regard to the specific nature of the tubercular diseases of the bones and joints. In an article written in 1878[1] he described the local lesions and the general process in these joints in a manner that never has been surpassed, and his conception of the specific nature of the process was almost as exact as if he had been able to demonstrate the presence of the tubercle bacillus. Hüter[2] and Schüller[3] inoculated animals with tubercular material, after contusion of joints, and produced characteristic tubercular inflammation of the injured joints. Koch's[4] discovery of the tubercle bacillus in cases of chronic tubercular disease of the joints settled conclusively the identity of these chronic diseases with tubercular lesions found in other parts of the body. More recent authors who have added to the knowledge of the pathology of these diseases are König, Krause, and Watson Cheyne.

Etiology. The direct cause of the chronic, so-called "tubercular," disease of the bones and joints is the tubercle bacillus. The proof of this statement depends upon the following facts: the constant presence of the tubercle bacillus in the diseased bones and joints; the occurrence in the diseased bones and joints of the same pathological structures as those produced by the tubercle bacillus in other tissues; the production of general tubercular disease in susceptible animals by inoculation with bits of diseased bone, abscess contents, fragments of synovial membrane, or sinus or abscess wall; the artificial production of tuberculosis of the bones or joints resembling the disease found in human beings, by inoculating susceptible animals with tissue from diseased bones or joints, or with pure cultures of tubercle bacilli; the production of tubercular disease of the bones or joints in men by accidental inoculation with tubercular material, and the frequent occurrence of general tuberculosis in individuals suffering from tuberculosis of bone or joint. Each of these points deserves special discussion.

Constant Presence of Tubercle Bacillus. Koch, in his first article on tuberculosis, states that he found tubercle bacilli in

[1] Volkmann. Klinische Vorträge, vi. 168–169 (Chir. 50).
[2] Hüter. Deutsch. Zeitschr. f. Chirurgie, 1872, xi. S. 317.
[3] Schüller. Experimentelle und histolog. Untersuchungen. Stuttgart, 1880.
[4] Koch. Berl. klin. Wochenschr., 1882, No. 15.

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four cases of "strumous" disease of the joints. Schuchardt and Krause also found tubercle bacilli in a number of cases of tuberculosis of the bones and joints, although the bacilli were few in number and were found with difficulty. Various other observers have confirmed these results. Müller examined many cases of tubercular bone disease, and stated that with care it generally was possible to find bacilli, although in some cases he was unsuccessful. Watson Cheyne[1] has examined pus, synovial membrane, and diseased bone from tubercular joints, and believes that with careful search bacilli always can be found, but that they generally are extremely few in number. He also states that by Ehrlich's method he frequently finds *blue* stained bacilli lying in giant and epithelioid cells of the tubercles, and believes that these are tubercle bacilli. He does not exclude the possibility that these blue micro-organisms may be due to a secondary infection of the tubercular tissue, and since the recognition of the tubercle bacillus depends entirely upon its characteristic staining reaction, and not upon morphology, it seems that Cheyne's assumption that his blue bacilli are tubercle bacilli is entirely unjustified. I have examined pus from tubercular abscesses, the walls of tubercular sinuses, tubercular synovial membrane from tubercular joints, and bits of tubercular bone. In pus from tubercular abscesses I have been able sometimes to demonstrate the presence of tubercle bacilli in very small numbers, but usually the bacilli could not be found. Examinations of the walls of tubercular abscesses, sinus walls, and soft tissues have almost always shown the presence of tubercle bacilli, usually in small numbers; examination of tubercular bone for the bacilli has been unsuccessful in most cases, even although bacilli were found in the soft tissues from the same cases. I believe that the difficulty in detecting the tubercle bacillus in diseased bone is due to the fact that, in order to cut microscopic sections of bone, the material first must be decalcified, preferably with 5 per cent. nitric acid. The prolonged soaking in the dilute acid (two to four days) in some way interferes with the staining reaction of the bacillus. Bits of tubercular lung, known to contain large numbers of tubercle bacilli, were soaked in 5 per cent. nitric acid for varying periods of time. After soaking in the acid for two days the bacilli

[1] Watson Cheyne. Tuberculosis of Bones and Joints, 1895, p. 80.

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stained faintly and in small numbers. After four days no bacilli could be detected.

PRESENCE OF "TUBERCLES" IN DISEASED BONES AND JOINTS. Characteristic microscopic tubercles, or diffuse tubercular tissue, is always present in the soft tissues (abscess wall, sinus wall, synovial membrane, adjacent soft tissues), and in the bone-marrow from cases of tubercular joint tissue. Sometimes the process shows definite miliary tubercles, sometimes conglomerate tubercles, sometimes a diffuse tubercular tissue, the latter commonly in the wall of tubercular abscesses. The microscopic structure of the tubercles varies through wide limits, as in other tubercular disease, but the characteristic element always can be recognized. This statement is confirmed by every writer upon the subject.

PRODUCTION OF TUBERCULAR DISEASE IN SUSCEPTIBLE ANIMALS. The production of general tubercular disease by inoculating susceptible animals with diseased tissue from tubercular bones and joints is simple and certain. It is the surest way to confirm a diagnosis in doubtful cases. The infectiousness of material from tubercular bones and joints was demonstrated first by Hüter[1] and Schüller,[2] before the discovery of the tubercle bacillus. They inoculated animals with tubercular material, and then contused or twisted the joints of the animals, and produced characteristic tubercular inflammation of the injured joints. Many other observers have produced general tuberculosis in susceptible animals by inoculating them with bits of diseased bone, synovial membrane, or tubercular pus. I have in many cases inoculated bits of tubercular bone, etc., into guinea-pigs, and always the animal has died in from four to six weeks with general tuberculosis of internal organs and with general tubercular enlargement of the lymphatic nodes. Detection of tubercle bacilli in these organs was an easy matter.

EXPERIMENTAL PRODUCTION OF TUBERCULAR DISEASE OF BONES OR JOINTS. The experiments of Hüter and Schüller have been mentioned. Müller[3] injected tubercular pus into the nutrient artery of the tibia in kids, and produced tubercular disease in the epiphysis, in some cases in the shaft of the bone and in the joints. Krause[4]

[1] Hüter. Deutsche Zeitschr. f. Chirurgie, 1872, xi. S. 317.
[2] Schüller. Exp. und histolog. Untersuchungen, etc. Stuttgart, 1880.
[3] W. Müller. Centralblatt f. Chirurgie, 1886, No. 14.
[4] Krause. Der Tuberc. der Knochen und Gelenk, 1891, p. 81.

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injected pure cultures of tubercle bacilli directly into the joints of animals. This injection was followed by heat, swelling, and immobility of the infected joint. Examination of the joint showed reddening and swelling of the synovial membrane and a general diffuse tuberculosis of the membrane. He also injected pure cultures of tubercle bacilli into the peritoneal cavity or into the bloodvessels of animals, and after an interval of a few days produced various injuries, sprains, or dislocations of various joints and fractures of bones. Many of the animals died of general tuberculosis before disease of bones or joints ensued. Many of the animals whose joints were sprained showed characteristic tuberculosis of the bone or joints. A few animals whose joints were dislocated showed tuberculosis of those joints. Fractured bones in every case healed without showing signs of tubercular infection. Watson Cheyne injected pure cultures of tubercle bacilli into joints and into the nutrient artery of the tibia of goats, and produced characteristic tuberculosis of the bones and synovial membrane.

Production of Tuberculosis of Bones and Joints in Human Beings by Direct Inoculation. The reported cases are few and not conclusive. Cases following local tubercular infection are reported, but, as a rule, tuberculosis of the bone or joint developed months or years later, and frequently at a distance from the original "surgical tubercle."

Occurrence of Secondary General Tuberculosis. As a clinical fact, the occurrence of general tuberculosis in patients with tuberculosis of the bones or joints is so well known that it only needs to be mentioned. A large proportion of children suffering from tubercular joint disease die of general tuberculosis. General infection is especially common after operations upon tubercular joints. Wartmann,[1] *e. g.*, states that after 837 resections of the hip, 10 per cent. of the cases died of general tuberculosis, which came on in such a way as to suggest that the operation stood in some causative relation to the process.

Predisposing Causes. Certain factors seem to favor the occurrence of tubercular diseases of the bones and joints. Congenital tubercular disease of the bones or joints never has been proved.

[1] Wartmann. Bradford and Lovett, quoted.

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Every one knows that in certain families there is an inherited predisposition to tubercular infection, but the cause of this predisposition is not understood. In 1842 cases of tubercular disease of various joints reported by Gibney,[1] C. Fayette Taylor,[2] and Croft,[3] 41 per cent. were in children, one or both of whose parents had phthisis. On the other hand, many individuals succumb to tubercular disease who, so far as can be ascertained, have no inherited tendency. Tubercular disease in general, and in tuberculosis of the joints especially, often first manifests itself after an attack of acute infectious disease, especially after measles and whooping-cough. Tubercular disease of the bones or joints frequently follows an injury of moderate severity. It is well known that in an out-patient clinic where many tubercular joints are seen the disease in the joint is almost always referred to some antecedent injury, such as a bruise or a sprain. Although many of these assigned injuries are afterthoughts, careful questioning shows that in a large proportion of the cases the injury appears to stand in some direct relation to the disease. Statistics upon this point are, however, of little value.

It is to be noted that, as a rule, the injuries assigned are of moderate severity—*e. g.*, sprains, contusions, and the like. The writer has found no fractures assigned as the cause. The French Ministry of War has long noted that most of the soldiers undergoing amputation of the leg for carious disease of the ankle attributed the disease to sprain. Krause's experiments on animals, already mentioned, confirm this statement. In animals tubercular disease of the joints and bones followed sprain, rarely dislocations, never fracture of bones. The reason assigned is that injuries of moderate severity cause an inflammatory exudation in the tissues at the point of injury, in which the bacillus finds favorable opportunity for development, if it obtains access to the body, while, if the injury is severe, the reparative process is so active that the bacillus is destroyed, even if it does obtain access. Whatever the cause, it is unusual for tubercular disease to follow severe injury.

Age. Tubercular disease of bones or joints is essentially a disease

[1] Gibney. "Strumous Element in Joint Diseases," New York Medical Journal, July, 1871.

[2] C. Fayette Taylor, from Preface of German edition of the "Mechanical Treatment of Pott's Disease."

[3] Clin. Soc. Transactions, London, vol. xiii.

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of childhood. Of over[1] two thousand cases reported by Gibney, Wright, Bryant, and Sayre, over 78 per cent. occurred under fifteen years of age. All writers agree that children between three and ten are more often affected than adults, although no age is exempt. Thorndike[2] has reported a case of hip disease beginning in the first week of life, and several cases of tubercular disease of spine and hip during the first six months. Tubercular disease of the joints is not rare under two years. Watson Cheyne[3] emphasizes the fact, however, that the apparent prodominance of cases of tubercular disease of joints in children is less than would appear at first sight, and says that the reason that more people are attacked with the disease during the first five years of life is that a greater proportion of people of that age are alive than of any other. He uses the German statistics of the proportion of persons per thousand alive at different ages, and shows that the real frequency of the disease is greater in advanced life than is generally supposed, although it is much greater in youth. The reasons assigned for this frequency are the assumed greater liability of bone to disease during the growing period, and the greater liability of children to falls and slight injuries. Various writers have shown the greater susceptibility to the disease of various joints at different periods of life. Hip, spine, and knee are the joints most frequently affected. Various writers have published statistics which agree with this statement.

Sex. The influence of sex upon the occurrence of tuberculosis of bones and joints appears not to be important, but the disease is somewhat more common in boys than in girls. Various writers have published statistics bearing upon this point. The reason assigned is the greater liability of males to injuries and sprains.

INFECTION. In tubercular disease of bones and joints, as in other tubercular processes, the tubercle bacillus may enter the body in various ways. The usual way is through the respiratory system. The bacillus may be inhaled and cause tubercular lesions of the lungs, or the bacilli may pass through the alveoli and affect the bronchial lymph nodes. Frequently the bacilli enter the body

[1] Bradford and Lovett, quoted.

[2] Thorndike. "Joint Disease in Infancy," TRANSACTIONS OF THE AMERICAN ORTHOPEDIC ASSOCIATION, 1896.

[3] Watson Cheyne. Loc. cit., p. 114.

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through the intestinal tracts—*e. g.*, in tubercular milk or by swallowing dried sputum, and cause tubercular ulceration of the intestine, or they may pass through the unbroken intestine and cause tubercular disease of the mesenteric lymph nodes. Or an individual accidentally may be inoculated directly with tubercle bacilli—*e. g.*, while operating upon tubercular tissues. This latter possibility is of little practical importance. In any case, at the point of inoculation a primary focus of tubercular disease develops, from which a general tubercular affection may result. The great majority of children with tubercular disease of the bones or joints who come to autopsy show tubercular foci in other parts of the body—*e. g.*, in lungs or intestines or bronchial or mesenteric lymph nodes. These foci, from their size and extensive caseation, must be considered as the primary focus of the disease, to which the lesion in the joint is secondary. It often happens that, besides the diseased joint, only lymph nodes show evidence of tubercular disease, and in such cases the original point of infection cannot be detected. From the primary focus the tubercular process may extend directly into a blood-vessel so that the bacilli get into the blood stream. Rarely an old scar of the lung, presumably produced by tubercular disease, is the only indication of infection besides the joint lesion. Such a case was seen at autopsy at the Children's Hospital, in 1895. Or rarely the joint lesion appears to be the primary tubercular focus. An autopsy upon a boy at the Children's Hospital showed advanced tuberculosis of the vertebræ, with a psoas abscess opening into the cæcum, and with marked amyloid disease of liver, spleen, and kidneys, but showed no tubercular disease of internal organs or of lymph nodes. So far as could be determined the bone disease was the primary tubercular focus. General tuberculosis may result from such a primary bone lesion. A girl of five years, who had had symptoms referred to the knee for three months, died at the Children's Hospital of general tuberculosis. At autopsy a primary tubercular focus was found in the epiphyseal line of the head of the tibia. No other tubercular focus or point of entrance of the bacillus could be found.

Histogenesis. I know of no description of the histogenesis of tubercular disease of bones and joints based upon the study of experimental lesions after definite intervals. The following description

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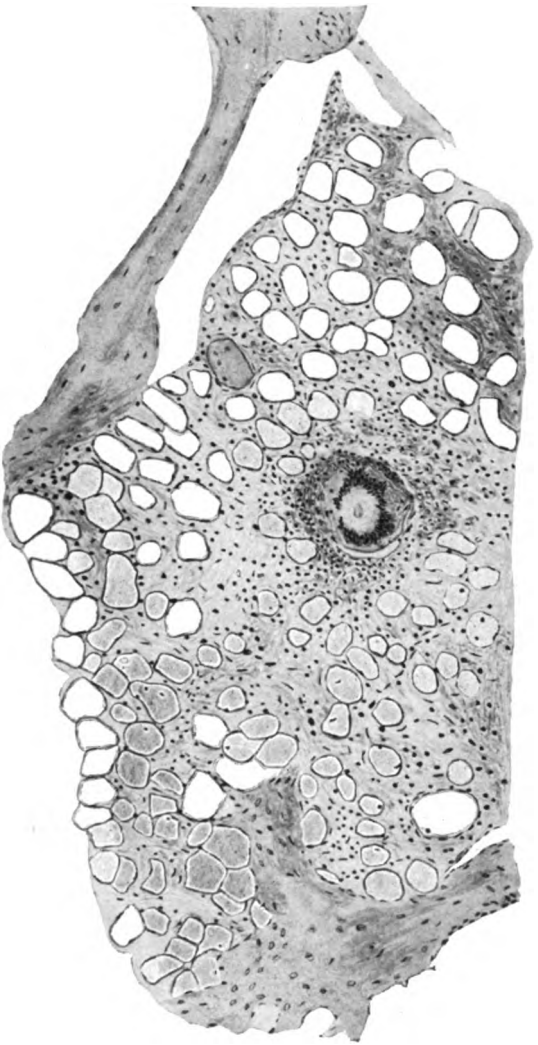
is based partly upon what is known of the development of tubercular lesions produced experimentally in other organs, partly upon

FIG. 1.



Solitary early tubercle in bone-marrow. Shows slight central necrosis and a giant cell, with peripheral arrangement of nuclei. About area of necrosis are epithelioid cells surrounded by a zone of lymphoid cells. Between fat spaces of marrow is œdematous fibrous tissue in which are many lymphoid and plasma cells.

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a study of young tubercles, as seen in the periphery of tubercular foci, and in a few cases of miliary tuberculosis of the bones, occurring in the course of a fatal general tuberculosis.

The tubercle bacillus, after being carried to and having lodged in the bone-marrow, causes a proliferation or multiplication of the surrounding fixed cells of the marrow, probably of the connective-tissue stroma. This proliferation results in the formation of more or less circular areas composed of "epithelioid" cells. These cells have an oval nucleus and granular protoplasm, the boundary of which is indistinct. The proliferation of the fixed connective-tissue cells probably is due to the action of a soluble toxin produced by the bacillus. Some of the areas of proliferation also contain large multinuclear cells, "giant cells," having numerous vesicular nuclei, sometimes twenty or thirty in number, which are arranged often in two groups, one at either pole of the giant cell, "bipolar" arrangement, or they may be situated about the periphery of the giant cell with their long axis directed toward the periphery, "mural" arrangement. The giant cells are not an essential constituent of the primary tubercle, but are very commonly present. Sometimes more than one giant cell is present. The giant cell usually is placed eccentrically, and the centre of the cell is finely granular or necrotic, and stains diffusely. Between the cells of the tubercle is a delicate meshwork or reticulum, probably composed of processes of epithelioid and giant cells. At a somewhat later stage surrounding the periphery of the mass of proliferated epithelioid and giant cells appears a zone of small round mononuclear cells, having a small, deeply staining circular nucleus, surrounded by a small amount of protoplasm, which often cannot be distinguished in individual cells. These are the "lymphoid" cells. Such an area, or early "tubercle," composed of a central mass of epithelioid and giant cells, surrounded by a zone of lymphoid cells, sometimes can be seen in the periphery of an advancing tubercular focus. No bloodvessels are formed in such an area.

As the tubercular area enlarges by multiplication of cells the centre of the area undergoes certain degenerative changes. The nuclei of the cells in the centre of the mass no longer stain, the outline of the cells is lost, and their protoplasm is changed into a finely-granular, homogeneous necrotic mass, in which sometimes small fat

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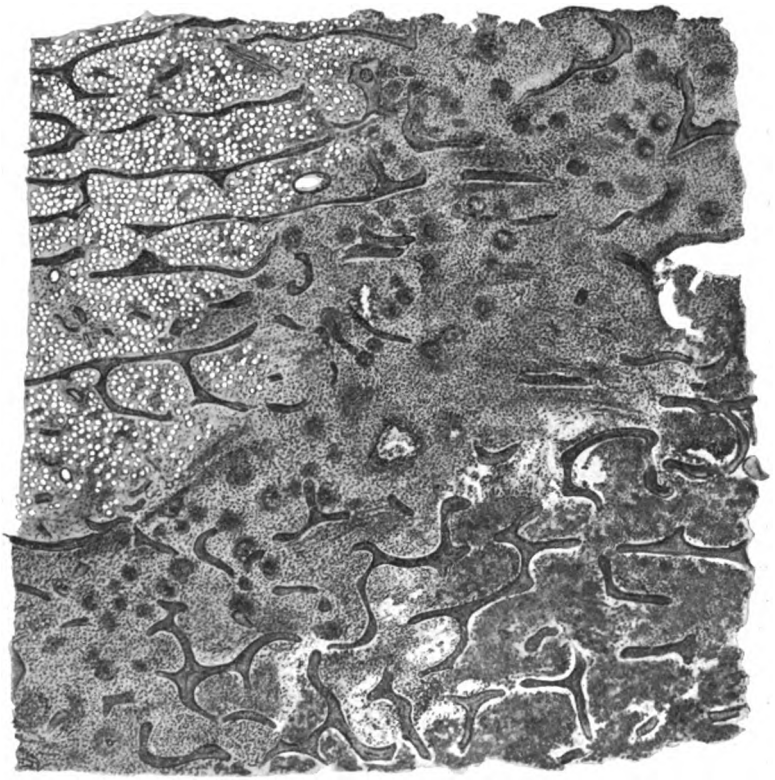
drops can be seen—*i. e.*, the centre of the tubercle "caseates." The caseation probably is due to the absence of bloodvessels and to the action of the soluble toxines produced by the tubercle bacillus. Sometimes the tubercle bacillus can be found, usually in small

FIG. 2.



Edge of tubercular focus in bone. Shows a portion of caseous marrow surrounded by necrotic bone trabeculæ. Surrounding caseous area is a band of single and conglomerate tubercles in cellular marrow; trabeculæ have not become necrotic. Surrounding tubercular tissue is fat marrow, in which is much œdematous fibrous tissue.

numbers, frequently lying in the giant cells, sometimes in the epithelioid cells, more rarely between the cells. A single tubercle seldom is much larger than the head of a pin. After caseation occurs a few polymorphonuclear leucocytes may be seen.

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Extension from Original Tubercular Focus. By multiplication of the tubercle bacilli and diffusion of the bacilli into the surrounding tissue, other similar secondary tubercles are produced about the original tubercle, and the centre of these tubercles in turn becomes necrotic. The necrotic centre of the primary tubercle enlarges, as do the centres of the secondary tubercles. At length the enlarging necrotic centres unite, coalesce, and form a conglomerate mass of tubercular caseation. By repetition of such a process large tubercular areas are formed.

In addition to the specific tubercular process just described there early appears about tubercular areas a non-tubercular granulation tissue, due probably to the chronic irritation produced by the presence of the tubercular process, which acts as a foreign body. During the early stages of the process this granulation tissue consists of an œdematous, delicate connective tissue, in which are many spindle-shaped connective-tissue cells with fine fibrillæ, while between the separated fibres is serum in which a little fibrin is seen. In this connective tissue are fairly numerous young bloodvessels. Between the vessels are many round or oval cells, the protoplasm of which stains a purple-red with hæmatoxylin and eosin, while the nucleus is eccentric and has dark-staining masses in its periphery—"plasma cells." There are also many "lymphoid cells." Polymorphonuclear leucocytes are few or absent. In the latter stages of the disease, when the reparative process is more marked, this œdematous connective tissue becomes less vascular and is converted into denser fibrous tissue, showing wavy bundles of intercellular substance between which are relatively few spindle-shaped nuclei, while lymphoid and plasma cells are wanting and bloodvessels are few or absent.

Anatomy in Long Bones. Tubercular disease of the large, long bones starts generally in the epiphyseal ends of these bones, in distinction from acute infectious osteomyelitis, which usually attacks the diaphysis of the bone. The process begins in the marrow of the bone, apparently never in cortical bone or in cartilage, while the supporting bony trabeculæ are affected only secondarily. The process, beginning in the method just described, seldom is seen in the earliest stage, but usually is examined after the area is of considerable size. Then the individual tubercles appear to the eye as small, circular, grayish or yellowish areas (proliferation or caseation), sur-

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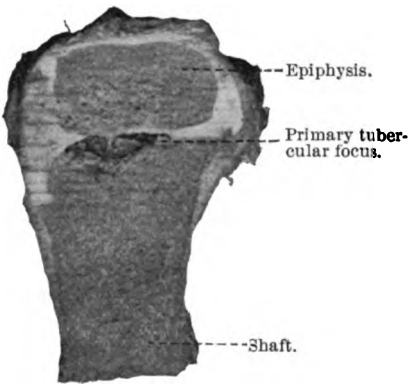
rounded usually by a thin circle of purplish-red granulation tissue. Such an area, beginning in the marrow, enlarges peripherally, although the individual tubercle never attains a size much larger than the head of a pin. Young secondary tubercles form about the primary tubercle, and their centre in turn becomes caseous. As the caseous areas enlarge they meet and coalesce, forming in the marrow of the bone irregular caseous masses with a crenated margin. The area includes a greater or less amount of bony trabeculæ. About this area of necrotic and caseous material is a layer of tubercular tissue, composed of single and conglomerate tubercles, while surrounding the tubercles is a layer, often quite wide, of purplish-red granulation tissue. By repetition and extension of this process large areas of bone may become involved. The further advance of the process takes place in one of several ways which will be discussed separately.

FIG. 3.



Knee-joint. Upper end of tibia opened in vertical transverse plane.
Tibia from early tubercular disease of knee-joint. Child of five years, who died of general miliary tuberculosis about three months after first symptoms. In upper end of tibia a small primary area of caseation in epiphyseal line, not opening into joint. Synovial membrane was thickened and injected, but showed no evidence of tubercular disease. Joint contained a considerable amount of slightly cloudy serum.

TUBERCULAR BONE-ABSCESS. The bony trabeculæ included in the caseous area may become necrotic, softened, and be partially or wholly dissolved and separated from the surrounding living trabeculæ. Ultimately the whole area affected becomes liquid, while in the liquid float remnants of partly-dissolved bony trabeculæ. This process makes a cavity, or "tubercular bone-abscess," containing a whitish,

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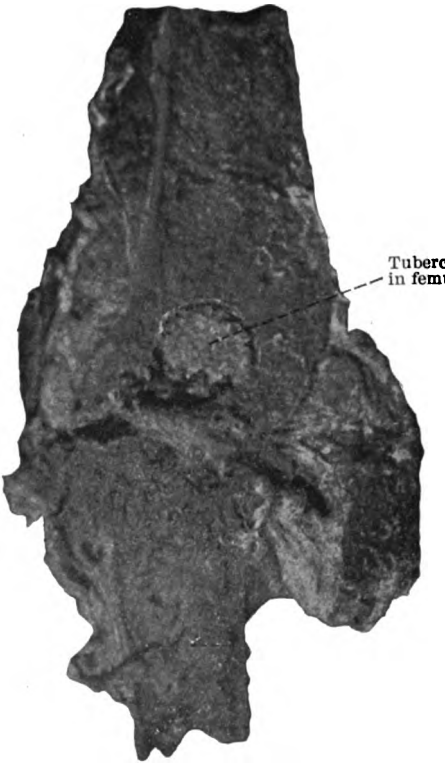
paplike fluid, in which are fragments of partly dissolved bone. The bone remnants may be very minute, "bone sand," or of appreciable size.

Usually about this bone-cavity is a definite thin layer of purplish-red soft tissue which can be lifted from the surrounding bone—a

FIG. 4.



Tumor albus. Adult. Amputation. Joint showed a general tubercular process, with no discernible connection with a bone focus. Vertical, antero-posterior section showed in head of tibia an approximately circular cavity, 3 cm. in diameter, filled with a caseous material and lined with a thin tubercular membrane. Process extended to joint, apparently along ligaments. Head of femur showed well-marked erosion.

tubercular "abscess-membrane." At other times there is no such line of demarcation, but the bony tissue surrounding the abscess is soft, yellow, and infiltrated with visible single and conglomerate yellow caseous tubercles. Rarely the bone surrounding the cavity is hard

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and sclerotic. This latter condition seems to occur only when the tubercular process extends slowly, and apparently is the result of an attempt to wall off the infectious process—*i. e.*, "sclerosis" is an indication of repair.

The microscope shows that the cavity is filled with tubercular pus, which will be described later. The bony fragments lying in the abscess or in the caseous material may retain the structure of bone, but the bone-corpuscles are necrotic and do not stain. Or the bony trabeculæ may appear rather granular, irregular in outline, and obviously dissolving. The abscess-membrane is composed of single and conglomerate tubercles, outside of which is œdematous connective tissue. The marrow spaces of bone for a considerable varying distance beyond the tubercular tissue are filled with this œdematous connective tissue. Usually these tubercular abscesses, if seen early, are irregularly circular. Older foci assume various shapes, which depend upon the direction in which the tubercular process extends, so that they may become oval, or long and irregular, extending from the original focus in various directions. Sometimes, if the diseased epiphysis is examined early, at the time when the marrow spaces are filled with caseous material, but before solution or sequestrum formation has taken place, one sees a pale, wedge-shaped area, with its base directed toward the cartilaginous end of the bone, while its apex is directed toward the shaft ("tubercular infarct"). The method of formation of such areas will be mentioned later.

Sequestrum Formation. Instead of producing a cavity filled with tubercular caseous material, the tubercular disease may lead to the formation of a "sequestrum" of necrotic bone. The process starts in the marrow in the manner just described, and extends until the marrow spaces over a considerable area are filled with caseous material. The trabeculæ in this area may become necrotic, yet retain their shape, and, for some reason, may not dissolve. Then the whole mass of diseased bone becomes separated, as a solid mass, from the surrounding bone, and forms a "sequestrum." Sequestrum formation is common, and is the rule in children.[1] The sequestrum lies in a cavity in the bone.

About the sequestrum, usually adherent to the walls of the cavity,

[1] Krause. Loc. cit.

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may be a thin layer of purplish-red tubercular tissue, like the already-described abscess-membrane. There may be no definite limiting membrane to the cavity, but the sequestrum may lie free in a cavity, the bony wall of which is softened and studded with single and conglomerate caseous tubercles. Krause says that this is more apt to be the case if there has been secondary infection of the area. The process, however, is not uncommon when no secondary infection has taken place. Finally, at times, the bony wall about the sequestrum is dense and sclerotic, but, as in the case of the tubercular abscess, this appears to be the case only when the reparative process is an active one. The bone-marrow spaces of the wall are for some distance filled with non-tubercular œdematous connective tissue. The sequestra seldom are of large size: rarely are they over 3 cm. in diameter. Usually they are single, rarely multiple. They are yellowish-white, and usually are irregularly circular in outline.

The microscopic examination of the sequestrum shows the bony trabeculæ often of normal shape; but they are necrotic, as the bone-corpuscles do not stain. The marrow spaces are filled with granular or homogeneous caseous material, or with necrotic marrow cells, whose cell outlines are largely lost, and whose nuclei do not stain.

"Bone Infarct." Sometimes the tubercular area in the bone is wedge-shaped, having the base of the wedge directed toward the articular cartilage, while the apex is directed toward the epiphyseal line. This condition is analogous to an infarct in other organs. Müller[1] showed that in some cases such an area was due to the plugging of a bone artery by a tubercular embolus. He injected tubercular pus into the nutrient artery of the tibia of kids, and produced characteristic wedge-shaped tubercular areas in the tibia, and the microscope showed an embolus containing many tubercle bacilli extending into the arterial branches. Such wedge-shaped bone-foci, therefore, always should be secondary to tubercular disease elsewhere in the body.

Besides the single tubercular area occurring in the epiphyseal end of a long bone, the epiphyses of several joints sometimes are affected, and sometimes the epiphyses of both bones entering into a joint are affected.[2] I never have seen the latter condition.

[1] W. Müller. Centralbl. f. Chirurgie, 1886, No. 14.
[2] Krause. Loc. cit.

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Extension of Epiphyseal Foci. Tuberculosis in organs other than bone is a self-limited disease. It is possible that small areas occurring in the epiphyseal ends of bone may undergo spontaneous cure, although demonstration of this fact is difficult. The process may cease to extend and the focus may be surrounded by a capsule of dense fibrous tissue. Generally, however, the process enlarges peripherally from the primary focus, and ultimately perforates the bone at some point. The extension sometimes is in such a direction that the perforation takes place through the cortex of the bone, outside of the joint. Such cases are rare. The best chance for such a favorable result comes when the primary focus is situated near the cortex of the bone. In certain joints—*e. g.*, the hip—the epiphysis is so much enclosed by the joint capsule that such a result is extremely unlikely to happen, although Volkmann says he has operated upon such cases. According to Krause,[1] extra-articular perforation is not uncommon when the primary focus is in the upper or lower end of the tibia or in the olecranon. Almost always the epiphyseal focus extends toward the cartilage of the joint and perforates the joint at some point, so that a general infection of the joint occurs.

Tubercular Disease of the Diaphysis of the Large Long Bones. The process so far considered has referred only to disease in the epiphyseal ends of the long bones. Volkmann[2] describes a diffuse tuberculosis of the bones which arises in the epiphysis and extends over nearly the whole shaft. He says that such a process may affect both bones of a joint. The whole marrow may be converted into a dry, yellow caseous mass, with here and there a little pus or a rare tubercle. Such cases, he says, are rare, and nothing but amputation is of use. Krause,[3] König,[4] and Ziegler[5] also describe this condition. I never have seen this form of the disease. Krause[6] claims to have seen primary tubercular disease of the diaphysis in large long bones. He says it always comes in children under four years of age who have tubercular disease elsewhere. Kahn[7] reports ten such cases, two of which were Krause's, already

[1] Loc. cit.
[2] Volkmann. Klinische Vorträge, series v. p. 1405.
[3] Krause. Loc. cit.
[4] König. Tub. der Knochen und Gelenke.
[5] Ziegler. Pathologische Anat., 1892, vol. ii. p. 150.
[6] Krause, p. 35.
[7] Kahn, H. Primare Tuberculose der Diaphysen der Langen Rohrenknochen. Wirzburg, 1893.

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mentioned, and eight of which were seen in Schonborn's clinic. All of these cases were clinical cases, none of which came to autopsy, and all occurred in patients with tubercular disease elsewhere. In all of the cases the disease extended to within a short distance of the epiphysis. Most of the cases were considered to be acute infectious osteomyelitis clinically. In only two was the presence of the tubercle bacillus demonstrated, although all showed characteristic tubercular lesions histologically. Considering the difficulty of exact examination of a bone at the time of operation, and the close proximity of all these diffuse areas to the epiphysis, it seems to the writer probable that the primary focus was in the epiphysis, and that the cases were like those described by Volkmann. At any rate, primary tubercular disease of the diaphysis is exceedingly uncommon.

FIG. 5.

Longitudinal section through spina ventosa of phalanx of finger. Shows original shaft, the marrow of which is caseous or infiltrated with tubercles. The articular cartilage is nearly normal. The periosteum is thickened and infiltrated with tubercles. There is no new formation of periosteal bone.

TUBERCULAR DISEASE OF THE SHORT LONG BONES ("SPINA VENTOSA"). Tubercular disease of the diaphysis of the short long bones—*e. g.*, the phalanges of the hand and foot—however, is not

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uncommon. The disease occurs usually in children. The process rarely is examined microscopically early, but in the late stages the bone appears larger in diameter than normal, and is flask-shaped. The marrow of the bone is almost entirely replaced by caseous tubercular material, in which is much bony detritus, composed of necrotic bony trabeculæ, or sometimes a large portion of the shaft is converted into a sequestrum. The increased size of the bone is due to the new formation of bone by the periosteum, which forms a new layer of cortical bone. Frequently the tubercular process extends outward beyond the cortical bone of the original shaft, and lies between the original cortex and the deeper layer of the new periosteal bone. The new periosteal bone may have its deeper layer attacked and destroyed by the tubercular process, while the outer layer constantly deposits new bone. The layer of periosteal bone may be very thin. Sometimes it is entirely destroyed, and only the periosteum itself remains as a dense layer of fibrous tissue enclosing the tubercular mass. Frequently the tubercular centre opens upon the surface by one or several tubercular sinuses. Usually the cartilaginous ends of the bone are not affected, but rarely two adjacent phalanges are diseased. Frequently several digits are attacked, and often the process is seen in children who have tubercular disease elsewhere. Krause[1] says that such digits may entirely heal and resume their normal condition. I have seen the process heal and entirely disappear in cases that clinically were tubercular. Frequently, after such an attack, the phalanx remains backward and does not develop as it should. Krause also has seen a similar process in the epiphyseal ends of other bones—radius, ulna, and fibula.

Tubercular Disease of Short Bones. Tuberculosis may attack the short bones—*i. e.*, those of the ankle and wrist. It is to be remembered that these bones all have a relatively large amount of spongy tissue and a thin cortex. As a rule, one such bone articulates with several similar bones. Under such circumstances a comparatively small tubercular focus may early involve several adjacent joints and bones. The cases which the writer has seen after amputation were from adults, in whom invariably several bones and joints

[1] Krause. Loc. cit.

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were affected, and the disease was so advanced that it usually was impossible to say what bone had been the primary focus.

Krause[1] says that in adults the process may arise in one or in several bones at the same time, while in children it often is confined to one bone, and the disease may remain circumscribed.

Tubercular Disease of Flat Bones. The shoulder-blade and clavicle are infrequently attacked. Tubercular disease of the sternum is not infrequent, and generally is very extensive. Tubercular disease of the ribs is common. It frequently arises as a tubercular periostitis, and sometimes, if the inner surface of the rib is affected, may lead to the formation of large abscesses between pleuræ and ribs. Tubercular disease of the pelvis is very common. It frequently begins in the acetabulum, and may extend outward and perforate into the pelvis and lead to abscess-formation in the pelvis. The flat bones of the skull rarely are affected. The process is apt to attack the parietal bones, and not infrequently leads to external abscess and sinus formation, frequently to complete perforation of the bone and opening of skull cavity, so that pulsation of brain can be felt. Sometimes the dura is covered with tubercular granulations. Tubercular disease of the face bones is most frequent in the lower orbital bone. This generally is seen in young children who have tubercular disease —*e. g.*, spina ventosa in other places. It may also occur in the nasal bones and leads to a tubercular ozæna. Tubercular disease of the lower jaw occurs.

General Miliary Tuberculosis of Bone. This occurs in connection with general miliary tuberculosis, but is of no clinical importance. The miliary tubercles are scattered throughout the marrow of the bones, and generally appear as small circumscribed nodules, composed of epithelioid and giant cells, surrounded by a thin zone of lymphoid cells. Necrosis generally is slight or wanting. There is usually little or no evidence of secondary inflammatory reaction.

Cold Abscess. The tubercular process is at first limited to the bones, begins focally and extends peripherally, and finally may extend to and destroy the cortex and periosteum, so that the tubercular process reaches the surrounding soft tissues. By formation, coales-

[1] Krause. Loc. cit.

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cence, and caseation of secondary tubercles in the soft tissue, a considerable area of tubercular softening is produced in those tissues. Into the softened area may be an exudation of leucocytes and serum, so that the caseous area softens and becomes fluid. Surrounding this softened area is a layer of tubercular tissue, about which is a more or less extensive layer of œdematous, vascular, granulation-tissue. By repetition of this process the cavity or tubercular abscess in the soft parts may attain a very large size, out of all proportion to the bone focus from which it arises. These abscesses, unless secondarily infected by pyogenic organisms, show no elevation of temperature above that of the surrounding tissues, hence the name "cold abscess." The tubercular abscess differs from an abscess produced by pyogenic organisms in the character of its contents and in the structure of its wall.

TUBERCULAR ABSCESS CONTENTS. The contents of a tubercular abscess are composed chiefly of the caseous material derived from the fusion of many caseous tubercles and of exuded serum, with necrotic shreds of partly destroyed soft and bony tissue. In the fluid also are many polymorphonuclear leucocytes which have exuded from the surrounding bloodvessels after necrosis has occurred. The gross appearance of the pus differs from that in an ordinary abscess. In small abscesses the contents may be thick and pap-like. In larger abscesses it is usually thin and watery, and contains large fibrinous coagula, leucocytes, fragments of necrotic tissue, and small or sometimes larger bits of necrotic bone, so that, if poured into a glass and allowed to stand, it separates into a thin, cloudy, serous upper and a thick lower layer. The pus in an uninfected abscess is usually whitish or pale yellow. Sometimes hemorrhage into such abscesses takes place, and they are red from the presence of fresh or brownish from decomposed blood. Microscopic examination of pus from cold abscesses sometimes shows the presence of tubercle bacilli, although generally the search must be a prolonged one. Krause[1] says that the bacilli can be found in the pus from one-third of these cold abscesses. Often careful search fails to detect the bacilli, but they probably are present in considerable numbers, for by inoculation of susceptible animals—*e. g.*, guinea-pigs—I never have failed to produce

[1] Krause. Loc. cit.

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general tuberculosis. Many of the polymorphonuclear leucocytes are necrotic.

WALL OF COLD ABSCESS. The wall of a tubercular abscess is composed of an inner layer of tubercular tissue, outside of which is

FIG. 6.

Wall of tubercular sinus. Shows numerous tubercular areas surrounded by œdematous granulation-tissue, in which are many lymphoid and plasma cells.

a more or less extensive layer of secondary inflammatory tissue. The inner layer seldom is over a millimetre thick, and is loosely attached to the inflammatory tissue, from which it easily can be separated. The inner layer often is composed of myriads of tubercles, raised above the surface, giving the wall a granular appearance. The

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apices of many tubercles are yellow and caseous. Between the tubercles the base may be injected, and coagulated fibrin may lie on the surface. Sometimes this inner surface of the tubercular layer may be necrotic, caseous, and ulcerated over extensive areas. The microscope shows the tubercular form to be composed of single and conglomerate tubercles, while the caseous form often is composed of a diffuse tubercular tissue, the inner surface of which is necrotic and caseous, while the outer layer is composed of a layer of epithelioid and giant cells, in which few definite tubercles are seen. Outside of this layer of tubercular tissue is a layer of lymphoid cells enclosed by a layer of dense fibrous tissue. The tubercular abscess enlarges peripherally by extension of the tubercular process. It extends in the line of least resistance, not necessarily downward. It may extend toward the surface of the body, and finally may discharge through one or more small openings in the skin. This leads to the formation of tubercular fistulæ.

TUBERCULAR FISTULÆ. The opening of tubercular fistulæ is generally small, circular, and is surrounded by a pouting protuberant ring of unhealthy looking granulation-tissue. Sometimes these openings enlarge and lead to the formation of quite extensive tubercular ulcers of the skin. Microscopic examination shows that the walls of these sinuses generally are composed of a diffuse tubercular tissue, outside of which is an œdematous granulation-tissue. Frequently the sinuses are multiple. As would be expected from their tubercular nature, they show little tendency to heal.

TUBERCULAR DISEASE OF THE JOINTS. As the tubercular bone-focus in the epiphysis enlarges it extends toward the surface of the bone. It may extend to and perforate the cortex, and extend to the soft tissues outside the joint—"extra-articular" perforation. A much more common result is for the tubercular area to extend toward the joint until it lies just beneath the articular cartilage. At this time, before the tubercular process has penetrated the joints, there frequently occurs a secondary non-tubercular inflammation of the joint. This inflammation is more apt to occur if the bony focus is a large one.[1] At this time the synovial membrane appears thickened, œdematous, and injected, and shows no sign of tubercular disease. The joint is filled with an inflammatory serous exudate,

[1] Krause. Loc. cit.

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sometimes of considerable amount. Clinically, the joint is swollen and motion is impaired. The writer has seen this condition at autopsy once. The knee-joint of a child of five years had been swollen for three months, and motion was limited, and there was a marked limp. The child died in a few weeks of general tuberculosis, and at autopsy a small primary tubercular focus was found involving the epiphyseal line of the upper end of the tibia and not opening into the joint. The synovial membrane presented the appearance described above. Volkmann[1] says that further permanent changes may occur. He claims that the joint can be obliterated partly or wholly by the formation of secondary inflammatory granu-

FIG. 7.

Perforation of articular cartilage from bone focus. Shows tubercle in bone-marrow Cartilage is somewhat fibrillated, and contains numerous irregular cavities filled with spindle-shaped cells.

lation-tissue, and that the clinical picture of fungous-joint inflammation may be produced. He says that a pannus growth of granulation-tissue may extend from the synovial membrane over the surface of the cartilage, and that the adjacent surfaces of the granulation-tissue

[1] Volkmann. Loc. cit.

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may grow together and partly or wholly obliterate the joint before it is perforated by the tubercular process. He also claims that this non-tubercular inflammatory obliteration of the joint may have a favorable effect upon the course of the disease if the tubercular process later does rupture into the joint, for there is a smaller joint-cavity to be infected, and the inflammatory tissue is more resistant to a rapid extension of a tubercular process than the uninjured synovial membrane would be. He says that this partial obliteration of the joint is more common in certain joints—*e. g.*, in the hip—and that under such circumstances in the knee only a portion of the joint is destroyed by the tubercular disease. I have never been able to demonstrate these extensive non-tubercular lesions that Volkmann describes. On the other hand, a tubercular pannus often does form and obliterate portions of the joint. The writer believes that the destructive results of this non-tubercular process are of less importance than Volkmann claims.

Perforation of Joints. The tubercular focus in the epiphysis may enlarge peripherally until it lies just beneath the cartilage. The cartilage over this area begins to disintegrate, and appears softened, fibrous, and yellow. Microscopic examination shows the surface of the cartilage near the bone rather fibrillar and no definite cartilage cells can be seen. In the cartilages are numerous irregular spaces, which are filled with spindle-shaped connective-tissue cells, which also extend between the fibrillæ. Ultimately these open spaces in the cartilage enlarge and extend toward the joint, and at length the cartilage is perforated at one or more points, and the tubercular material enters the joint. It frequently happens that the tubercular process perforates the joint near the attachment of ligaments, so that ligaments frequently are destroyed early.

The tubercle bacilli having obtained entrance to the joint are disseminated throughout the synovial fluid by the movements of the joints. The synovial membrane of the joint soon becomes infected, the bacilli probably being taken into the lymph vessels and lodging in the synovial membrane near the surface. About these bacilli tubercles develop. The synovial membrane then appears thick, smooth, and shining, sometimes slightly nodular. The surface is studded with grayish or yellowish areas, not exceeding in size the head of a pin. Between these areas the membrane is injected. This

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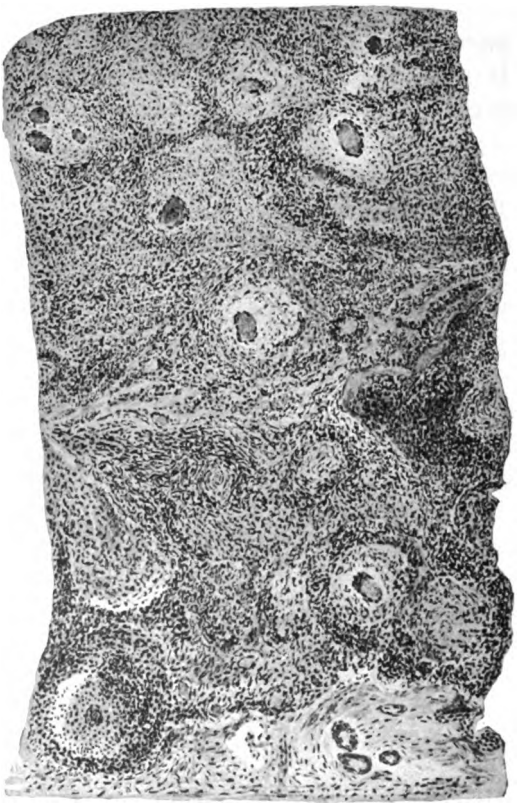
tubercular membrane is rather firmly attached to a thicker fibrous base. Later the yellow tubercular areas enlarge, coalesce, and soften, and finally large tubercular ulcers of the synovial membrane are formed. Comparatively early the thickened synovial membrane

FIG. 8.



Section of tubercular synovial membrane. Shows numerous tubercles containing giant cells Tubercles are separated by œdematous granulation-tissue in which are many lymphoid and plasma cells. The base of the membrane is composed of dense fibrous tissue.

may extend over the surface of the articular cartilage as a pannus-like growth, thinnest at the advancing edge. It may extend over the entire cartilage. This pannus is usually studded with a few scattered tubercles near its synovial edge, while the advancing edge is a

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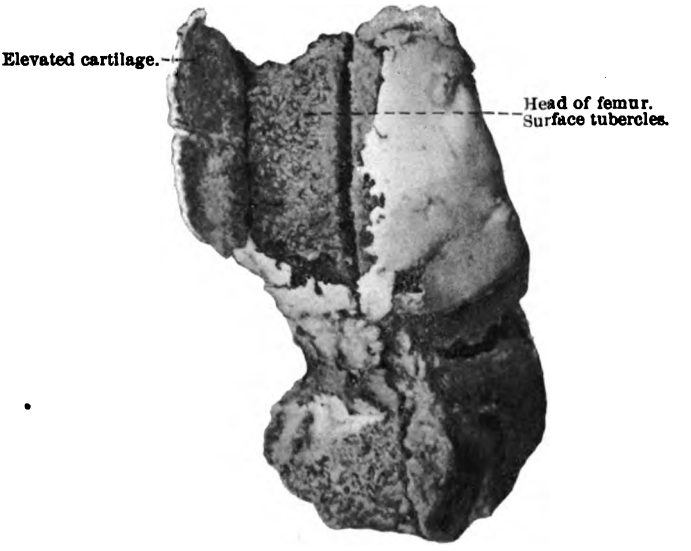
thin red membrane, often containing no visible tubercles. Under the microscope this advancing edge generally is composed of epithelioid and spindle-shaped cells; sometimes it contains a few tubercles, sometimes no tubercles are visible. At the same time the tubercular process may extend from the synovial membrane *beneath* the outer edge of the cartilage and grow between cartilage and bone. Usually in this layer there are fairly numerous single and coalescing tubercles; sometimes in places, as in the pannus layer, only epithelioid

FIG. 9.



Hip-joint. Excised head of the femur. Articular cartilage has been turned up on one side and shows underlying bone studded with tubercles Primary focus was in acetabulum and extended to femur, along round ligament, and beneath the cartilage.

and connective-tissue cells are seen, while the marrow spaces below this layer are filled with œdematous, vascular connective tissue. The cartilage in contact with the pannus layer is destroyed and disintegrated, just as it is in the perforation of cartilage by the focus in the bone. The upper surface becomes fibrillated, cartilage cells disappear, and irregular spaces filled with spindle-shaped cells appear. Extensive ulcers of the cartilage may appear covered by adherent pannus membrane. The osteal layer of cartilage also is eroded and destroyed if the tubercular tissue extends beneath the cartilage.

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Oftentimes large areas of cartilage are separated from the underlying bone, sometimes the entire cartilage, especially in the hip-joint. When this cartilage is removed the denuded end of the bone is seen covered with nodular granulation-tissue in which may be seen fairly numerous tubercles, some of which are caseous. The cartilage may be perforated from below in numerous places, giving a pepper-box appearance to it. As the disease progresses the cartilage is partly destroyed, or raised in large, irregular sheets, or entirely lost, or circular or irregular islands of cartilage remain. The denuded bones, on either side of the joint, are attacked by the tubercular process, and are eroded and become smaller. They often are worm-eaten in appearance. As a result of this destructive process, the articular ends of the bones are destroyed, articular cavities are enlarged and distorted, and various dislocations or subluxations may occur, depending upon the character of the joints. Special instances will be mentioned under the different joints.

CONTENTS OF JOINT. After a joint is penetrated by the tubercular process there usually is an increase in the amount of fluid in the joint. The character of the fluid is variable. Early in the process the exudate generally is clear, or may be slightly turbid from the presence of a small number of polymorphonuclear leucocytes. Later, if the cascation is marked the joint may be filled with an opaque fluid containing clots of coagulated fibrin, necrotic shreds, and very numerous polymorphonuclear leucocytes, producing the so-called "joint abscess." Sometimes, instead of fluid tubercular pus, there may be a thick, yellow, pasty mass.[1] Sometimes the fluid in the joint is reddish or brownish from recent or old hemorrhage. Sometimes the fluid in the joint is small in amount and caseation is slight, the so-called "caries sicca." This form of disease is most common in the shoulder-joint. Histologically, this disease does not differ from other tubercular joints, so far as my experience goes.

Two other types of tubercular synovial disease must be mentioned —the arborescent form and the solitary tubercles of the synovia.

ARBORESCENT TUBERCULAR SYNOVITIS. Rarely the whole synovial membrane is beset with long, branching arborescent tags, frequently covered with a layer of fibrin. The single tags often are

[1] Krause. Loc. cit.

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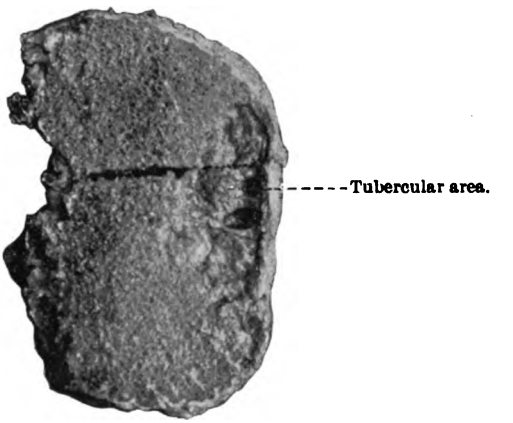
of considerable size and are pedunculated. These tags, microscopically, consist chiefly of a very vascular connective tissue, in which are fairly numerous tubercles. The tags sometimes are so vascular as to resemble angiomata. Sometimes in the tags is an excessive amount of fatty tissue, producing the so-called "lipoma arborescens."[1] This form is rare, and I have never seen a good example.

SOLITARY TUBERCULAR NODULES OF THE SYNOVIAL MEMBRANE. Solitary tubercles are said to occur[2] as firm, circumscribed nodules of the synovia, with little tendency to caseation, surrounded by synovial membrane. I have never seen them.

RICE BODIES. Sometimes on opening a tubercular joint, especially the serous or dry forms, there are found in the joints spherical or ovoid bodies, smooth, shining, opaque, and grayish, the so-called "rice bodies." Sometimes they are free in the joint, sometimes pedunculated. They usually consist of concentric layers of fibrin, sometimes they consist of vascular connective tissue. They may be fibrinous, coagular, shaped by the constant motion of the joint which rolls one mass upon another, or they may be pinched off synovial tags.

FIG. 10.



Tubercular disease of knee. Excision. View from above of upper end of tibia. Shows large oval area of tubercular softening. Clinical history not known.

SECONDARY OR PRIMARY TUBERCULAR SYNOVITIS. Most writers upon tubercular disease of the joints state that the disease of the

[1] Krause. Loc. cit.

[2] Krause. Loc. cit.

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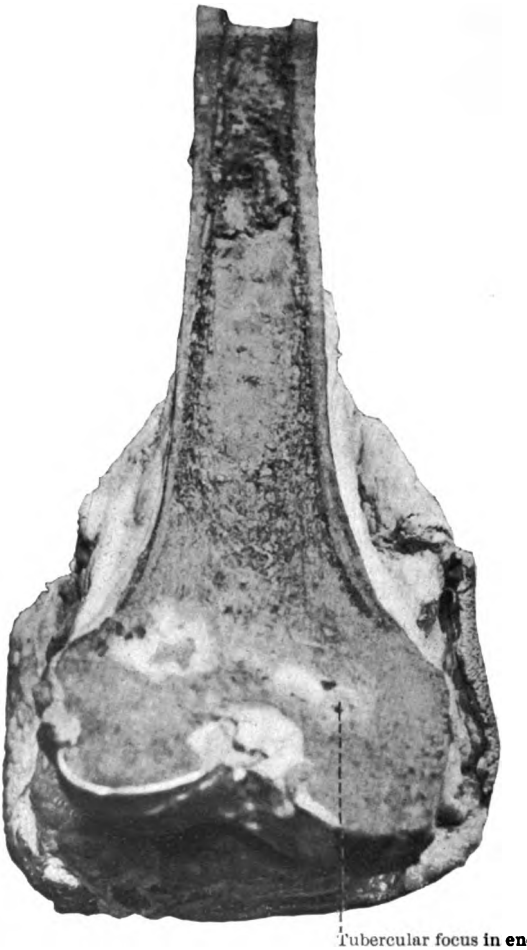
joint may be secondary to a tubercular focus in the epiphyseal end of an adjacent bone, or that the synovial membrane may be prima-

FIG. 11.



Tubercular disease of knee-joint. Woman, aged fifty-five years. Joint showed general miliary tuberculosis of synovial membrane; connection with bone focus not visible. Vertical transverse section through femur showed large irregular area of tubercular softening in epiphyseal end of femur extending into joint along crucial ligaments. No erosion of bone.

rily affected. The question is an important one clinically, and deserves careful consideration.

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Volkmann,[1] in his unexcelled description of tubercular joints, says, "The fungous inflammations of the joints begin generally, and in children almost without exception, not at all as an arthropathy, but as a pure osteopathy, with a very circumscribed caseous or tubercular osteitis." In another place he states that sometimes in adults the synovial membrane is primarily affected without preceding bone disease. Later writers all state that primary synovitis occurs, and that it is not uncommon. Krause,[2] for instance, reporting a series of cases seen *at operation*, says that 23 per cent. of the cases of tubercular disease of the joint were primarily synovial, and that the percentage of primary synovial disease varies with different joints. He believes that the cases secondary to a primary tubercular disease of bone are more numerous than primary synovitis up to fourteen years. Watson Cheyne states that primary tubercular synovitis is common, and recommends removal of the diseased synovial membrane from such joints.

During the past three years I have examined about 120 tubercular joints, from children and adults, many from excisions, a considerable number from autopsies or amputations, and never have seen a joint in which, if all bones entering into the joint were sawed open in thin layers, one or more old bone foci were not found. Four times after amputations, joints simulating primary tubercular synovitis have been examined, in which most careful search of the entire joint was made without detecting any connection with the bone focus. In every case when the bones were opened an extensive area of caseation was found in the bones, and in every case the line of extension into the joint was found. Krause[3] casually states that the more one makes it a rule to saw open the bones the less often will cases be considered primary diseases of the synovial membrane. In view of my own experience, I believe that primary tubercular synovitis is exceedingly uncommon, that examination at the time of operation is of no value, and that no case should be considered as primarily synovial unless each and every bone entering into a joint is sawed into thin sections not over one centimetre in thickness and carefully examined. Certain theoretical facts also support this view. It is certain that tuberculosis always arises as a focal disease and

[1] Volkmann. Loc. cit. [2] Krause. Loc. cit. [3] Krause. Loc. cit.

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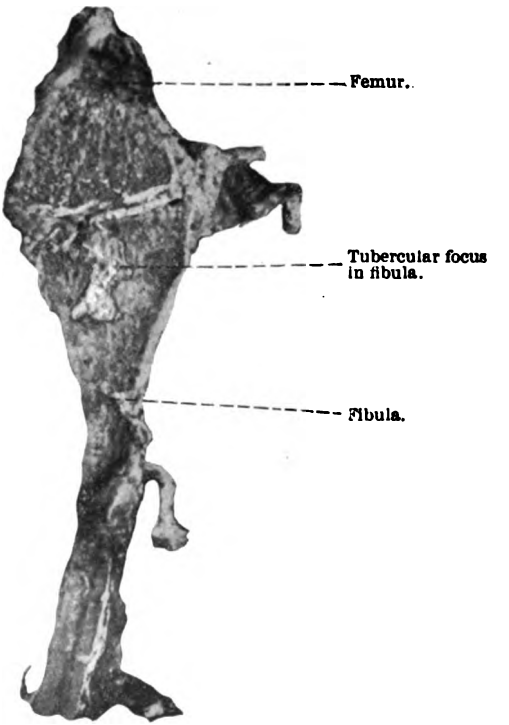
extends peripherally. Most tubercular joints show that every part of the joint was attacked simultaneously; whereas if the disease began in the synovial membrane, at some point in the membrane the primary focus could be seen. Some writers (Krause, Kōnig, Watson Cheyne) describe cases of circumscribed tubercular disease of the

FIG. 12.



Fibula from tumor albus of adult. Clinical history not known. Joint showed general tubercular synovitis, with no discernible connection with bone focus. Primary focus of tubercular caseation in head of fibula. No other bone showed softening. Cartilage covered a thin layer of tubercular pannus.

synovial membrane, but such cases certainly are exceedingly rare, and I never have seen one. It must also be remembered that complete examination of a joint at the time of operation is usually difficult, and often impossible, because of the complicated structure of the joint. It should be borne in mind, also, that the focus may be small and easily overlooked, and that all bones entering into a joint

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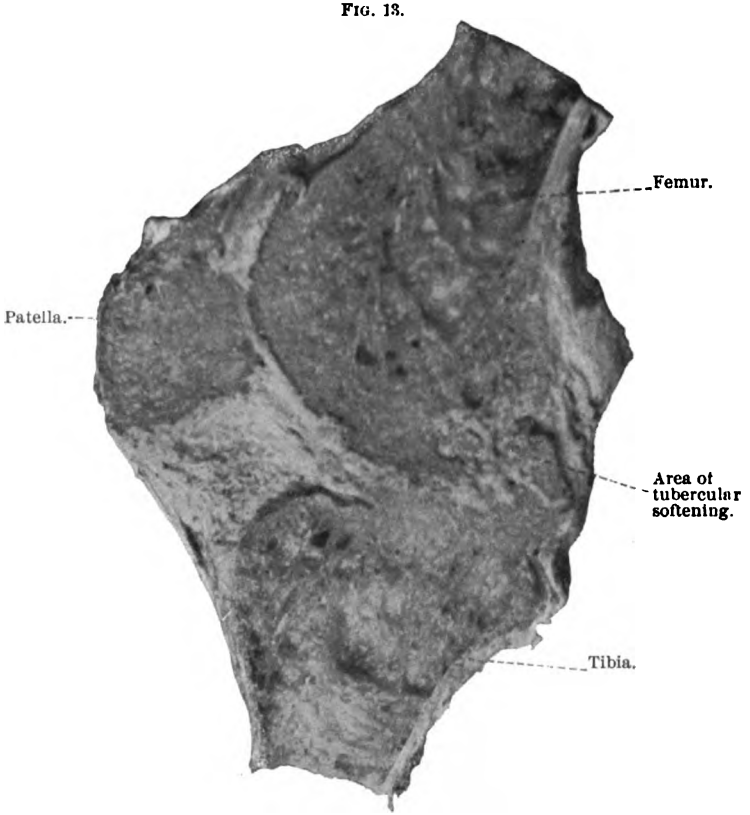
may not be examined to a sufficient depth. If sufficiently careful examination is made it will be found that an exceedingly small per cent., if any, of the cases arise as a primary synovitis.

SECONDARY DISEASES OF THE SOFT PARTS. About any tubercular process in bone or in soft tissue is formed a layer of granulation

FIG. 13.



Tubercular disease of knee-joint. Process of repair advanced. Bony and fibrous anchylosis of femur and tibia. Small persisting focus of tubercular softening in lower end of femur. Longitudinal antero-posterior section.

tissue which may be converted ultimately into dense fibrous tissue. This secondary inflammatory tissue-formation may be very extensive. Sometimes this fibrous tissue forms a dense sheath which includes the whole joint—*e. g.*, in tumor albus. The same thing often happens about the hip-joint, and frequently gives rise to the so-called "bony"

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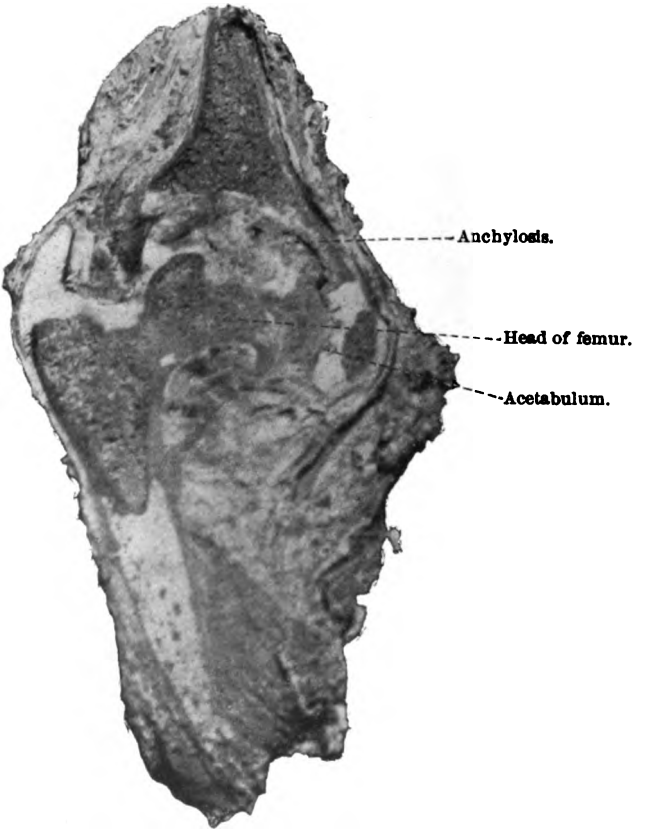
thickening about the trochanter. Oftentimes this fibrous tissue is œdematous, and the spaces in the tissue often contain a fluid which reacts to stains like mucin; sometimes the tissue is almost myxomatous.

REPAIR. Tuberculosis is a self-limited disease, and so at any stage of it the process of repair may begin. It is perhaps con-

FIG. 14.



Tubercular disease of hip-joint. Vertical horizontal section through femur and acetabulum. Head of femur distorted and eroded, but still lying in acetabulum. Some erosion of acetabulum upward. No evidence of primary focus. Marked bony, cartilaginous, and fibrous anchylosis of femur and acetabulum.

ceivable that very small tubercular foci may be absorbed. Practically, repair is brought about by the formation of fibrous tissue,

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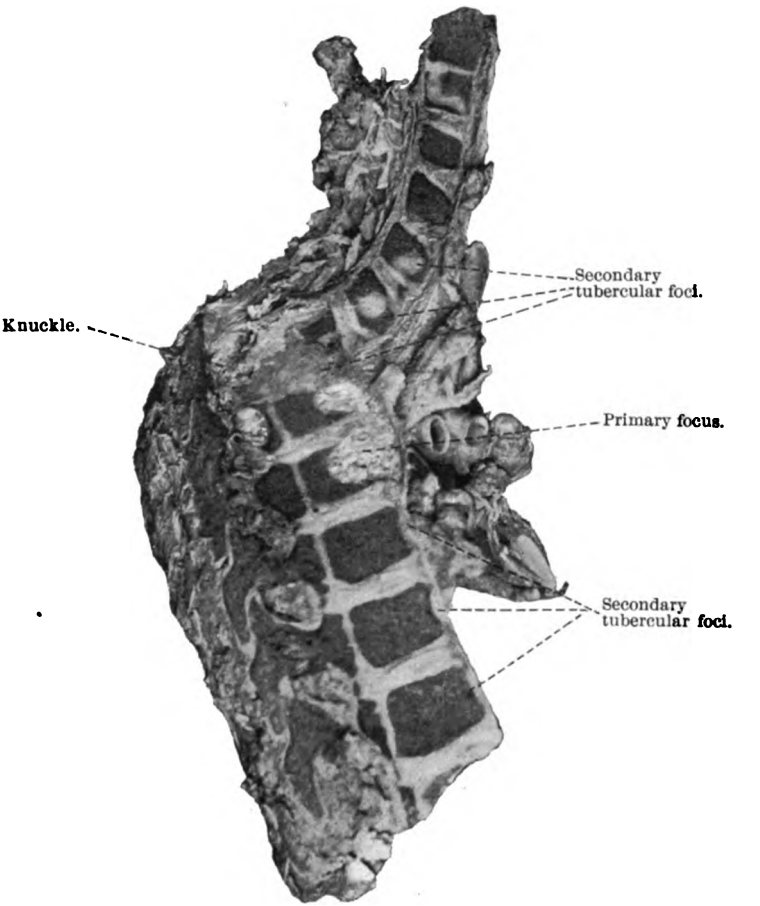
probably arising from the layer of non-tubercular granulation-tissue, which grows into and replaces the tubercular material. Cavities in bone are filled with fibrous tissue. Sequestra of small size may be

FIG. 15.



Spine. Cervical and upper dorsal vertebræ. Child. Vertical antero-posterior section. Tubercular areas in anterior portion of eight vertebræ. Prominent knuckle. Large tubercular area in one vertebra, with smaller areas in adjacent vertebræ. Prevertebral ligament pushed forward opposite largest tubercular area (beginning abscess).

encapsulated. Caseous material is largely absorbed, and the inspissated remainder is replaced by fibrous tissue, or is calcified and

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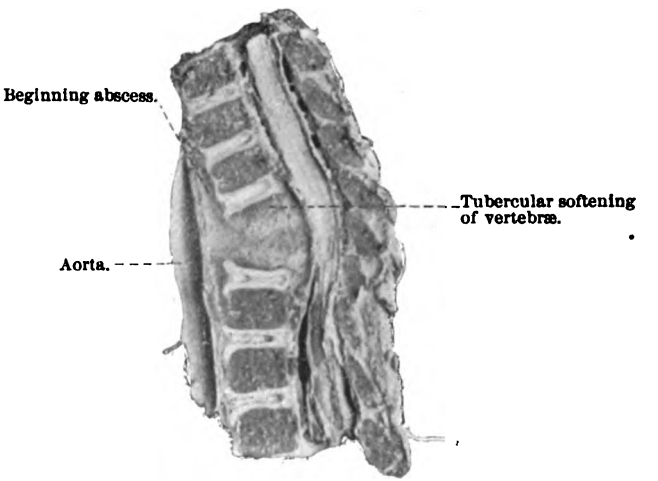
encapsulated. Adjacent joint surfaces may be bound firmly together by fibrous tissue, with consequent limitation of motion, "fibrous anchylosis," or the connective tissue may be converted into cartilage, "cartilaginous anchylosis," or into true bone, "bony anchylosis." Usually the anchylosis of adjacent bones is a mixture of all three processes. The joint cavity may be diminished or almost entirely destroyed. The process of repair often is incomplete, and small areas of tubercular tissue, encapsulated by fibrous tissue, may persist for months, and, under favorable circumstances, again become active and cause a recurrence of the tubercular disease. If the destruction of the joint surfaces has been extreme and the resulting dislocation or subluxation is a marked one, the healing may lead to anchylosis in the deformed position. The periosteal overgrowth in "spina ventosa" may disappear, and the bone apparently return to normal size.

FIG. 16.



Spine. Lower dorsal region. Child. Vertical antero-posterior section. Slight knuckle. Large area of tubercular softening, involving two vertebræ. Intervertebral disk destroyed. Process extends forward beneath prevertebral ligaments, and pushes aorta forward. Process also extends backward to dura.

SPECIAL JOINTS. The general process already described explains most of the changes that occur in the bones and joints. Certain joints, however, from their peculiar anatomy, show certain modifications of the general process.

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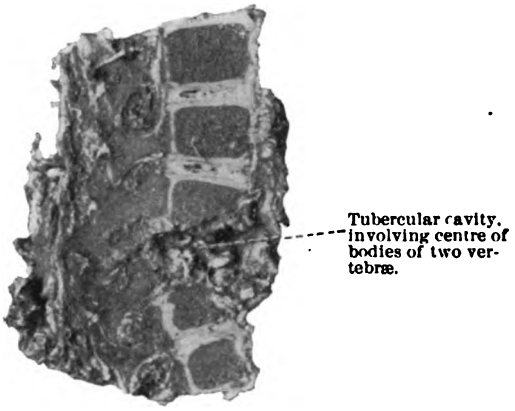
TUBERCULAR DISEASE OF THE SPINE. The disease begins usually in the marrow of the anterior portion of the body of a vertebra, and produces an area of tubercular softening and caseation. The process generally extends forward to the deep layer of the prevertebral ligaments, which act as the periosteum of the vertebræ, and then extends upward and downward from the original focus. As the disease reaches the level of each vertebra it attacks the body of that vertebra and forms a new area of tubercular softening. Often several vertebræ show such areas. The vertebra primarily attacked shows the most extensive areas of softening while those on either side show gradually smaller areas. Sometimes the disease begins deep in the body of the vertebra. As the area of softening increases the body of the vertebra is no longer able to sustain

FIG. 17.



Spine. Lower dorsal region. Child. Vertical antero-posterior section. Extensive tubercular softening involving two vertebræ; intervertebral disk destroyed. Knuckle very slight, probably because the focus was in the centres of the vertebral bodies, and laterally destruction was not complete.

weight, and the upper comparatively sound vertebra may crush into the diseased body, or the upper and lower surfaces of a body are pressed together. As a result, the spine becomes concave anteriorly and convex posteriorly, so that a prominence of the spine appears posteriorly—*i. e.*, a "knuckle" forms. In the early stage of the process only one or two of the vertebræ are so softened as to

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take part in the knuckle formation, and for that reason the angle of the beginning knuckle is an acute one, "angular curvature of the spine." As the number of softened vertebræ increases the angle becomes larger and somewhat more rounded, although it still remains comparatively acute. At first the intervertebral disk is spared, but if two adjacent vertebræ are extensively diseased the intervening cartilaginous disk is attacked from either side, becomes fibrillated,

FIG. 18.

Spine Lower dorsal region. Child. Vertical antero-posterior section. Specimen hardened in upright position, so that gravity presses diseased vertebræ together. One intervertebral disk destroyed. Extension of process backward to dura and forward along prevertebral ligaments. Moderate knuckle.

and disintegrates, and at length entirely disappears. Sometimes the greater portion of the centre of a body is destroyed, while the periphery remains comparatively sound, so that little convexity of the spine is produced. The character and the shape of the knuckle depend upon the extent of the disease and the portion of the spine affected. In the cervical region there sometimes appears to be a projection forward of the entire upper portion of the spine. Sometimes the softening begins at one side of the vertebræ or in a trans-

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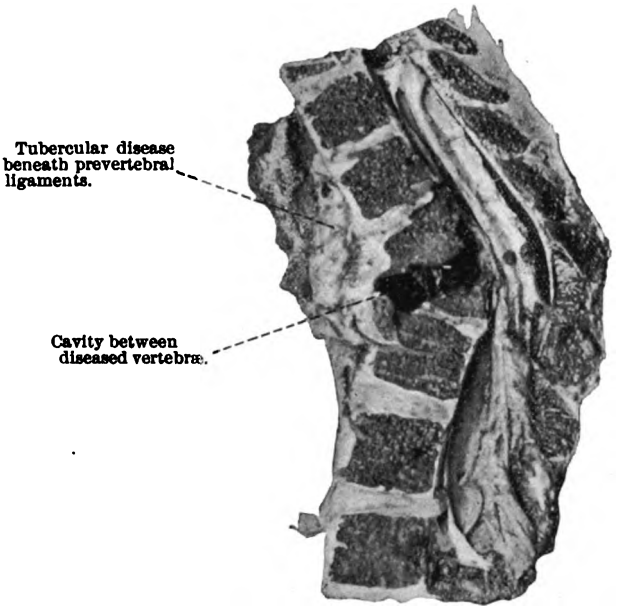
verse process, and in such a case a lateral bowing, "scoliosis," of the spine occurs.

ABSCESS FORMATION. In a considerable proportion of cases of tubercular disease of the spine no abscess is recognized during life, but in cases seen at autopsy an abscess is almost invariably found, although it may be of small size. The tubercular material early

FIG. 19.



Spine. Lower dorsal region. Child. Opposite half of specimen No. 16. Specimen rested upon knuckle while hardening, so that gravity extended the spine. Marked separation of diseased vertebræ.

pushes up the prevertebral ligaments, and forms a flattened, soon a nodular, swelling in front or sometimes to one side of the vertebræ. The contents of such a swelling are like the contents of other tubercular abscesses. The abscess, once formed, extends in the line of least resistance, generally downward, sometimes upward. If the bone disease attacks the cervical vertebræ the abscess, even if relatively small, may push into the pharynx ("retropharyngeal abscess"), and cause dangerous obstructive symptoms by pressure upon the larynx. Or such an abscess may open into the sub-

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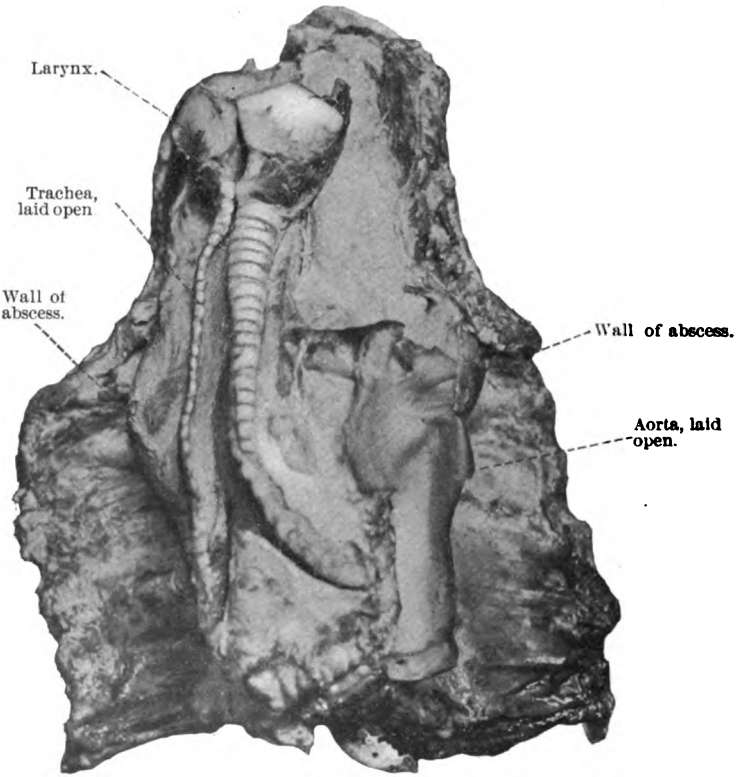
occipital region, or in the anterior triangle, or in the axilla, or may push into the posterior mediastinum. Such an abscess, as it descends, or an abscess arising at a lower level, may pass backward and appear in the lumbar region, or may extend forward along the

FIG. 20.



Spine. Lower cervical and upper dorsal regions, seen from the front. Child. Trachea is dislocated to right, large vessels to left, by large tubercular abscess.

wall of the chest, or may burst into the pleura or lungs. Still lower, an abscess may extend beneath the sheath of the ilio-psoas muscle and appear above Poupart's ligament, as an iliac abscess, or may extend beneath Poupart's ligament and appear in front of the thigh, or may entend to the knee, or may extend to the obturator foramen and appear over the buttock or in the perineum. Sometimes such

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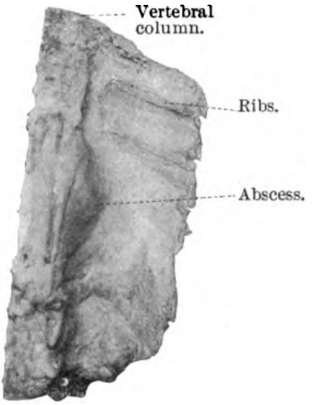
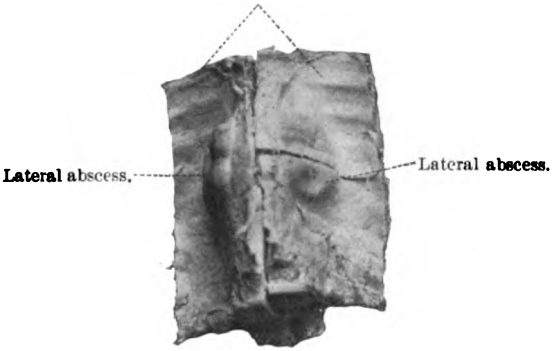
an abscess opens into one of the large vessels and causes sudden death from hemorrhage.[1] Rarely an abscess opens into a hollow abdominal viscus—intestine or bladder.

FIG. 21.



Spine. Vertical antero-posterior section. Child. Only one-half of spine, with ribs attached, is shown. Dorsal region. Shows early tubercular spinal abscess projecting in front of and to one side of spine. Seen from the front.

FIG. 22.



Spine. Mid-dorsal region, with portion of ribs attached. Child. Vertebræ seen from the front. Small tubercular abscess projecting on either side of the spinal column.

SECONDARY CHANGES IN THE SPINE. To compensate for the kyphosis of the spine produced by the knuckle there comes a com-

[1] Hoffa.

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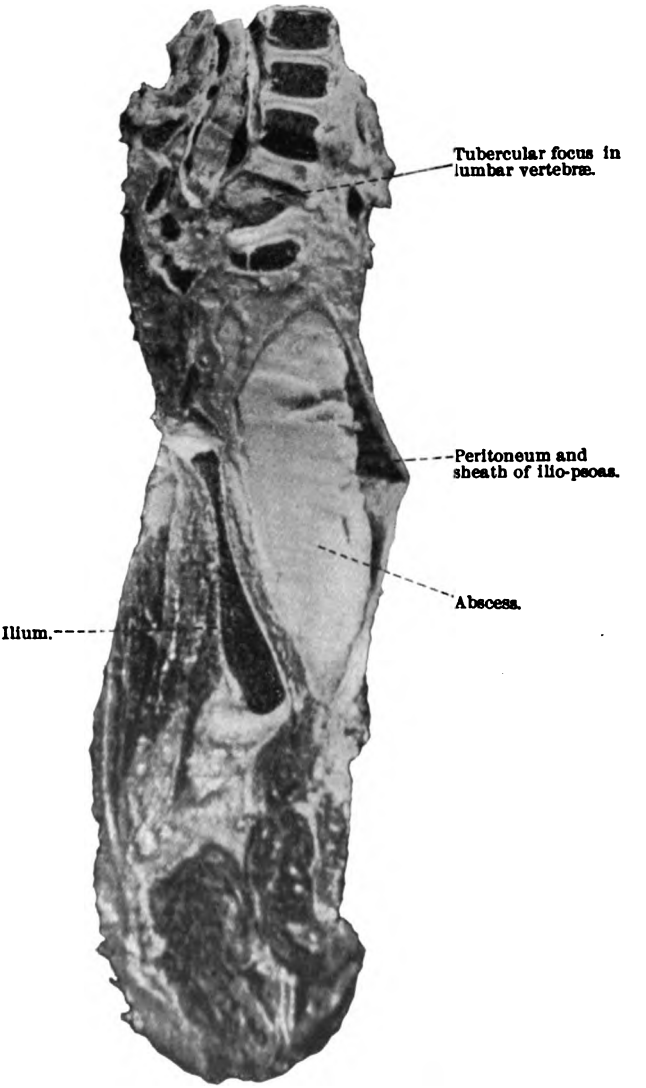
pensatory lordosis of the regions not affected. If the knuckle occurs in the cervical region the dorsal curve is partly obliterated;

FIG. 28.



Spine. Lower lumbar region and pelvis. Child. Section is made obliquely through lumbar vertebræ and ilium in the line of the ilio-psoas muscle. Small tubercular area in lowest lumbar vertebra. In pelvis is large tubercular abscess in sheath of ilio-psoas muscle.

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if the knuckle is in the dorsal region the cervical and lumbar regions are lordotic, while if the knuckle is in the lumbar region the dorsal curve is partly obliterated.[1] If the knuckle is a large one there are secondary changes in the ribs and pelvis. Under long-continued pressure bones act as if they were plastic, and alterations in their shape occur. In high dorsal disease the chest is elongated vertically

FIG. 24.

Spine. Low dorsal and lumbar region. Young adult. Extreme knuckle; lower ribs resting upon pelvis. Change in angle of ribs, due to continued deformity. Calibre of spinal canal not diminished.

and flattened antero-posteriorly. If the knuckle is a low dorsal one the chest becomes pyramidal in shape and the breast-bone is prominent. If the curve is in the lumbar region the chest may be pressed down until the ribs rest upon the pelvis, or the pelvis itself may be flattened. It is said[2] that in cervical caries the bones of the skull are distorted so that the relations of the various diameters of the skull are altered.

BLOODVESSELS. Certain extraordinary distortions of the large vessels may occur in connection with the formation of the knuckle

[1] Hoffa.

[2] Hoffa.

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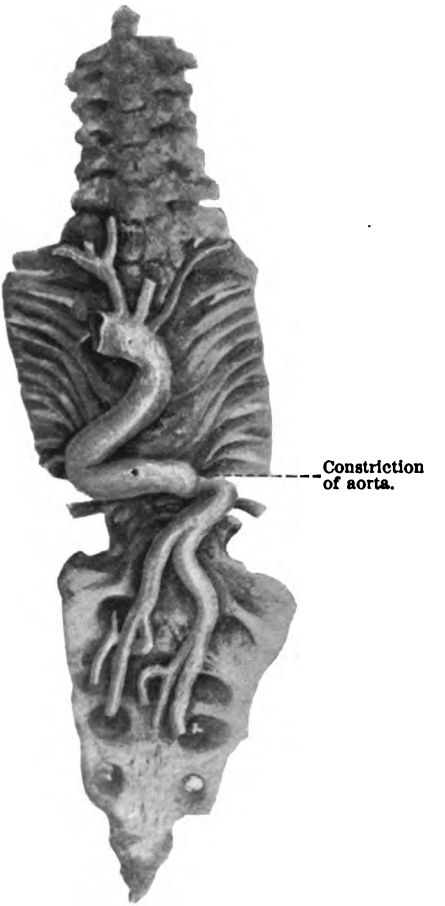
in tubercular disease of the spine, but they are not known to be of clinical importance. The distortions are of various sorts. Since

FIG. 25.



Distortion of aorta. From a case of spinal caries in an adult. Copied from Dwight.

Spine and pelvis, with portions of ribs attached. Adult. Clinical history not known. Front view. Shows aorta *in situ*, thrown in a series of convoluted folds. At one point a marked constriction of calibre of vessel. Angular deformity very marked.

the aorta is closely attached to the spine it may follow the anterior concavity of the column, making a sudden bend, with a V-shaped angle, open in front. Or the aorta may be pushed forward by an

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abscess and assume the form of a C, open behind. Or the aorta may be pushed to one side, like a C placed laterally, or may show a double lateral curve, like an S. Or, finally, it may be thrown into a series of complicated curves. This type of distortion usually is associated with abscess-formation. The extreme bending may cause a kink or constriction of the aorta at some point, and so diminish the calibre of the aorta at that point. Hoffa claims that the extra work required to drive the blood through the constriction may dilate the heart.

FIG. 26.

Spine. Low dorsal and upper lumbar regions. Child. Vertical antero-posterior section. Tubercular softening in anterior portion of bodies of five vertebræ. Marked knuckle. Portion of one vertebra has been pressed backward into spinal canal, but does not produce pressure upon spinal cord.

SPINAL CORD. A common clinical complication of tubercular disease of the spine is the so-called Pott's paralysis. Certain points in the etiology and course of this paralysis are obscure and deserve extended mention. Mere angular deformity, even when of an extreme degree, does not diminish the calibre of the canal sufficiently to cause bony pressure upon the cord. Occasionally, according to Hoffa, one case in fifty in which Pott's paralysis occurs, if a vertebra is rapidly and extensively destroyed, the upper segment of the spine may crush a fragment of the diseased vertebra backward in such a way as to produce direct bony pressure upon the cord. Bony pressure of this sort probably would cause degeneration and softening of the cord at the point of pressure; since the central nervous

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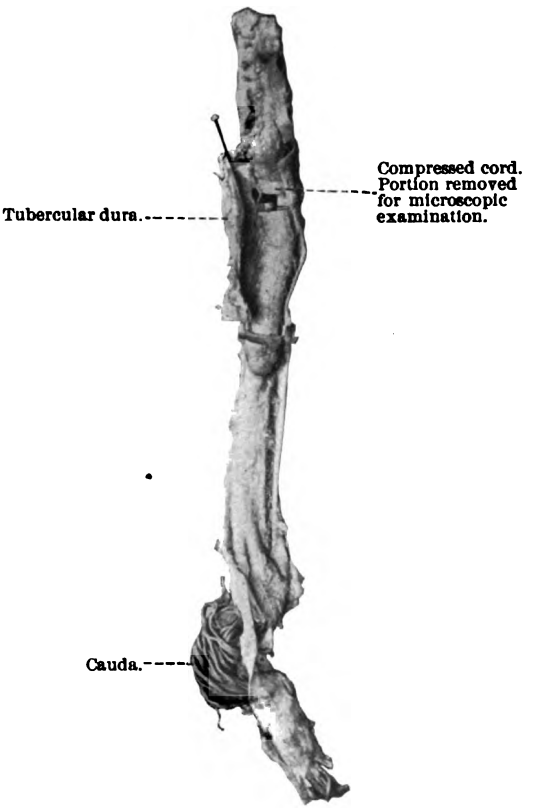
system, once degenerated, cannot regenerate, paraplegia due to this cause presumably would not recover.

The common cause, however, of Pott's paralysis is an extension backward of the tubercular process to the anterior layer of the dura, producing a tubercular peripachymeningitis. The tubercular tissue

FIG. 27.



Spine. Cord from a case of Pott's paralysis. Dura is thickened by mass of tubercular granulations. Cord much compressed by tubercular granulations at one point.

may involve the anterior surface of the dura or may extend entirely around it. The tubercular mass may cause sufficient pressure upon the cord to interfere with its functions. Sometimes the pressure thus produced is sufficient to cause degeneration of the cord at the point of greatest pressure, with an ascending degeneration of the

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sensory tracts above and a descending degeneration of the motor tracts below the softened area. It is a well-known clinical fact, however, that most cases of Pott's paralysis recover complete function. To explain this we must assume that the cord is able to withstand a pressure that is applied gradually, although the pressure may be sufficient to interfere with its function, or, as Schmaus[1] claims, that the paralysis is due to an œdema of the cord. Schmaus states that the lymph-vessels of the cord may be obstructed by tubercular disease of the dura, and says that in one case of Pott's paralysis he found the cord swollen and œdematous *below* the point of greatest pressure produced by tubercular external pachymeningitis, and that the point of greatest degeneration was in the œdematous part of the cord. He claims that the disappearance of the paralytic symptoms is due to a disappearance of the œdema, while if the œdema persists long enough softening of the cord may occur, with secondary degenerations of the motor and sensory tracts. Rarely the paralysis is due to pressure produced by a tubercular abscess outside the dura. In tubercular disease of the spine, as a result of pressure, the cord is at times certainly greatly compressed, and degenerates at the point of greatest pressure, while the sensory tracts above and the motor tracts below undergo a secondary degeneration. Sometimes,[2] as death approaches the tubercular process extends through the dura and may attack the cord itself.

Spinal Nerves. The tubercular process as it extends into the spinal canal may extend to the openings in the spine through which the spinal nerves have their exit. The tubercular mass in this way may press upon and paralyze large nerve trunks.

Repair. As in other joints, tubercular disease of the spine may cease to extend, and the tubercular area may be replaced by fibrous tissue. This fibrous tissue may be converted into bone, and several vertebræ may be anchylosed into one bony mass. If the knuckle is a large one the weight of the portion of the body above the knuckle pressing at great mechanical advantage upon the distorted spine may gradually convert the acute angle into a rounded one, even after the acute process has ceased.

Hip-joint. As a whole, the tubercular process in the hip-joint is

[1] Schmaus. Die Kompressions Myelitis bei Karies der Wirbelsäule. Wiesbaden, 1890.
[2] Hoffa, Schmaus.

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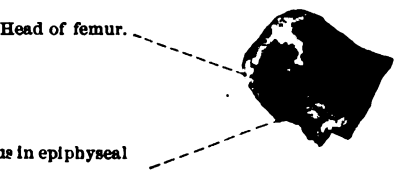
like the general process already described, but there are one or two special features. The process may begin in the head of the femur or in the acetabulum. If it begins in the head of the femur an extra-

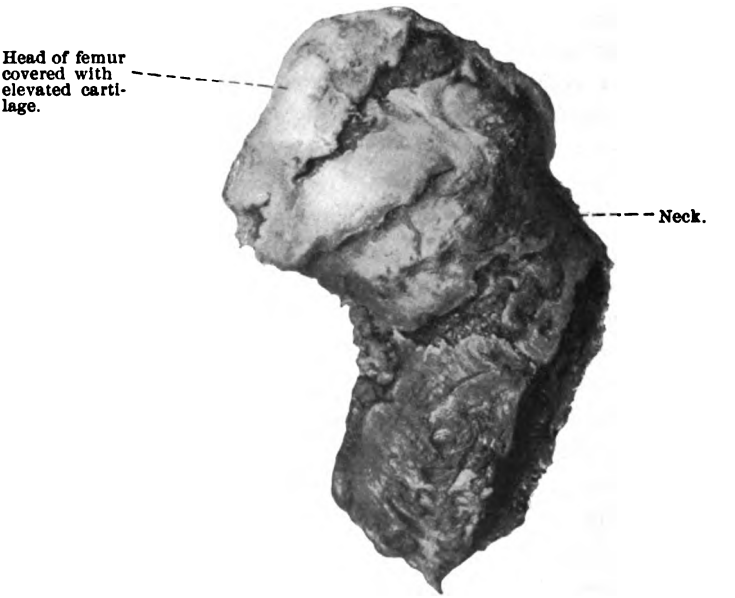
FIG. 28.



Hip disease. Primary tubercular focus in head of the femur, near epiphyseal line.

articular breaking through of the disease is not common. In the femur the disease frequently begins in the epiphyseal line between

FIG. 29.



Hip disease. Primary focus in acetabulum. Process extended to head of femur along round ligament, with destruction and erosion of articular cartilage from below.

the head and neck. The process may be so extensive as to cause a fracture of the neck, while the head may remain in the acetabulum. In a very large proportion of cases of hip disease the process begins

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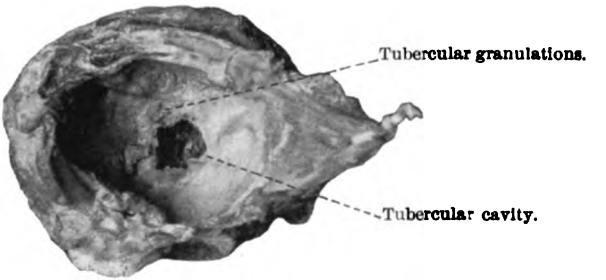
in the acetabulum. My attention was first called to this point by examining several specimens obtained by excision of the hip, in which very careful microscopic examination of sections from every

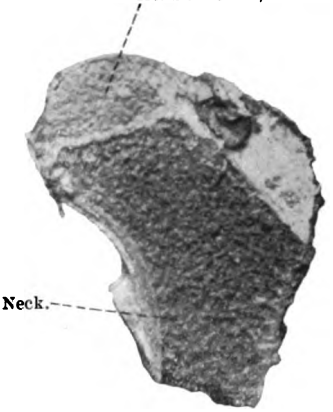
FIG. 30.



Hip. Acetabulum, seen from outside. At a point corresponding to attachment of round ligament is an opening, which during life was filled by a sequestrum. About margin of cavity were well-marked tubercular granulations.

part of the bone failed to show any characteristic tubercular disease. Since in this city excision rarely is done, except for very intractable

FIG. 31.
Head of femur, eroded and denuded of cartilage.



Hip. Head and neck of excised femur. Same case as No. 28. Head denuded of cartilage, eroded, and diminished in size. Careful gross and histological examination showed no tubercular tissue. Marrow spaces near articular surface were filled with secondary, non-tubercular granulation-tissue.

cases, and since the cases clinically were perfectly characteristic of hip disease, the only explanation seemed to be that the primary focus occurred in the acetabulum. An autopsy upon a compara-

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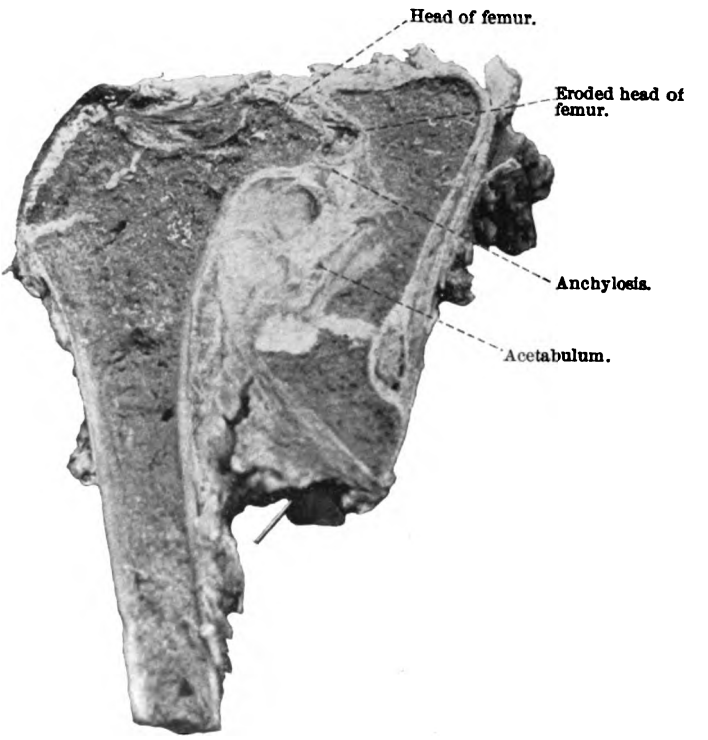
tively early hip case confirmed this opinion. At the autopsy the head of the femur was stripped of cartilage, eroded, and much diminished in size. Microscopic examination of many sections showed no tubercular tissue, but the marrow spaces near the surface of the bone were filled with œdematous fibrous tissue. In the centre of the base of the acetabulum was an irregular cavity, in which lay a sequestrum

FIG. 32.



Hip-joint. Vertical section through femur and ilium. Head of femur is eroded, distorted, and diminished in size, and is partly dislocated from acetabulum. Acetabulum is enlarged upward, and upper lip is partly destroyed. Fibrous anchylosis between femur and acetabulum. No sign of primary focus.

of tubercular bone. Numerous later cases confirmed this view. The process usually appears to enter the joint along or in the vicinity of the round ligament.

In the hip, after the joint is affected, muscular contraction draws the head of the femur upward and backward. As a result of tuber-

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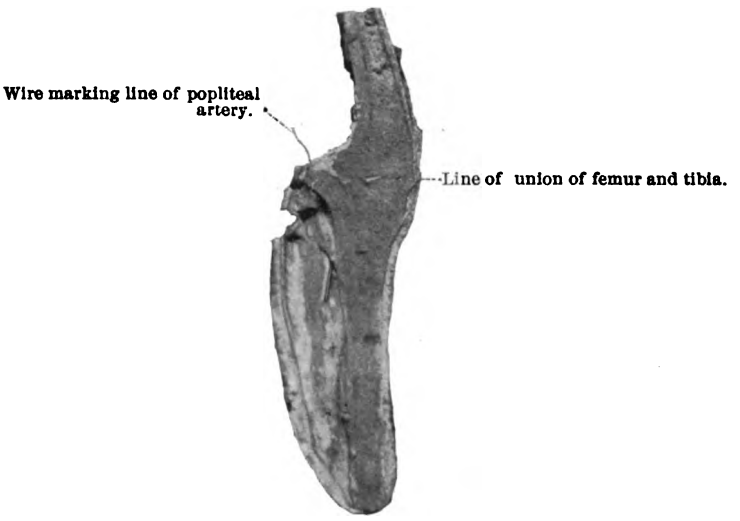
cular softening and pressure the acetabulum may be enlarged upward and backward—"wandering acetabulum." Enlargement of the acetabulum and erosion of the head of the femur may lead to partial or complete luxations of the head of the bone. Not infrequently a tubercular acetabular focus may penetrate into the pelvis and produce extensive pelvic abscess, which later may appear upon the surface in unusual regions—*e. g.*, in the perineum.

KNEE-JOINT. The disease may begin in any of the bones which enter into the articulation, femur, tibia, and rarely the patella. I have seen two cases of primary tubercular disease of the patella, and

FIG. 33.



Knee-joint of child of thirteen years. At eight years tubercular disease of knee and erosion of joint. After-treatment neglected, and deformity recurred. At thirteen years, excision of ends of bone and leg straightened. Gangrene of toes followed. Vertical antero posterior section. Wires show upper and lower ends of popliteal and posterior tibial arteries. Artery was partly occluded by projecting spur of tibia.

once the primary focus was in the head of the fibula. Muscular spasm leads to flexion and subluxation backward of the tibia upon the femur. This backward subluxation should be borne in mind when such deformities are corrected. In one case under observation a flexed knee was forcibly straightened, but the backward subluxation was not corrected, and the posterior surface of the tibia pressed

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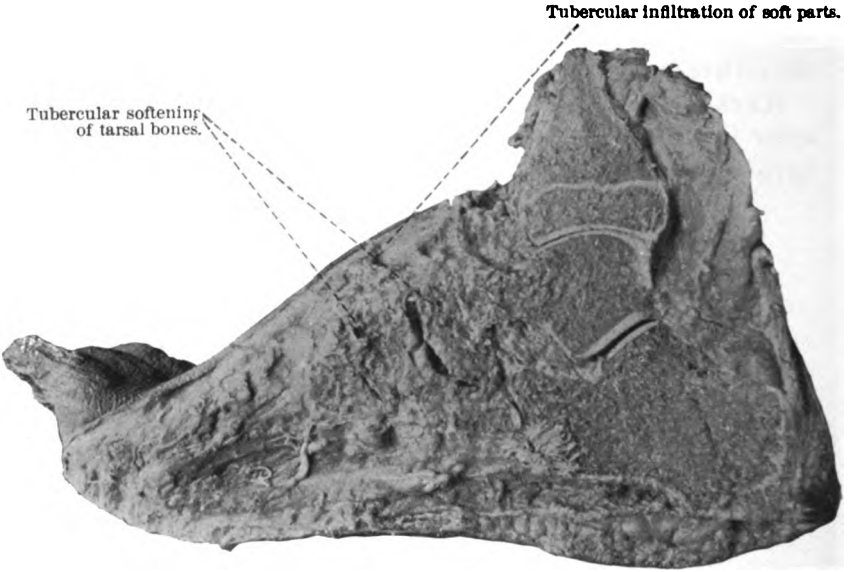
upon the popliteal artery and occluded it so that gangrene of the toes ensued.

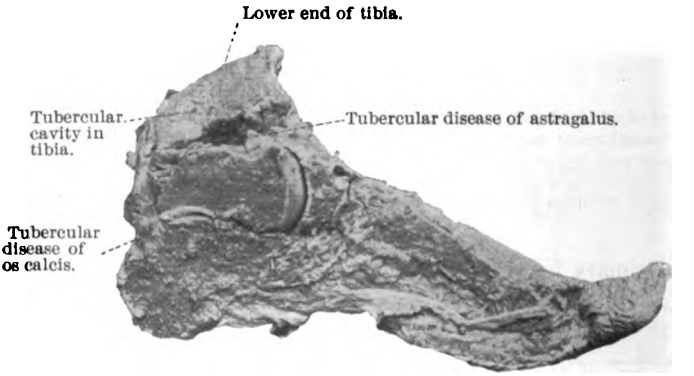
ANKLE-JOINT. The tubercular process may begin in any bone of

FIG. 34.



Ankle-joint. Adult. Vertical antero-posterior section. All of tarsal bones and soft tissues are converted into a diffuse tubercular mass in which bony outlines are lost. Primary focus cannot be detected.

FIG. 35.



Ankle-joint. Vertical antero-posterior section through tibia and foot. Adult. In lower end of tibia is a tubercular cavity in which was a sequestrum, now removed. Tubercular process has destroyed upper surface of astragalus, and has extended beneath tendo Achillis to os calcis.

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the tarsus, or the primary focus may be in the lower epiphysis of the tibia. If the disease begins in any of the short bones of the tarsus, extension of the process may lead quickly to breaking through into two or more joints. As a result, many of the tarsal bones are affected early, and the whole tarsus and surrounding soft parts may be converted into a tubercular mass, in which bone outlines are lost and the primary focus cannot be detected.

SUMMARY. 1. Many observations prove that tubercular disease of the bones and joints is produced by the tubercle bacillus.

2. Congenital tubercular disease of the bones and joints is not proved.

3. Injuries of moderate severity favor the production of the disease.

4. In the long bones the disease, as a rule, begins in the epiphysis.

5. Tubercular disease of the joints is generally, if not always, secondary to disease in the epiphysis in adjacent bone.

6. "Cold abscess" is due to extension of the tubercular disease to the soft parts. The wall of the abscess and its contents are unlike those of infectious abscesses.

7. Repair is brought about by the formation of fibrous tissue which replaces or partly encapsulates the tubercular tissue. Repair may be incomplete. Fibrous bands may cause fibrous anchylosis of joints, or the fibrous tissue may be ossified and result in bony anchylosis.

8. Paraplegia in Pott's disease rarely is due to bony pressure. Usually the pressure is caused by tubercular external pachymeningitis, or perhaps to œdema. Sometimes pressure or œdema leads to degeneration of the cord.

9. Hip disease frequently begins in the acetabulum.

10. Tumor albus may begin in any bone of the knee-joint. Muscular action produces flexion and backward subluxation of the leg. Extension of the leg without correction of subluxation may occlude the popliteal artery.

11. Caries of the ankle may affect many bones and joints early.

12. Inoculation of susceptible animals is the surest way of determining the character of doubtful joint or bone lesions.

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DISCUSSION.

DR. J. COLLINS WARREN, Professor of Surgery in Harvard University, opened the discussion. He said that the occasion reminded him of an incident that occurred while he was a student in the Jefferson Medical School in Philadelphia. He was attending the lectures of the late Professor Gross, one of the leading spirits in the medical profession in this country. Professor Gross was giving a demonstration of so-called scrofulous disease of bone, and he introduced an eminent practitioner of New York, Dr. L. A. Sayre. In doing so he said: "Dr. Sayre has certain theories about the morbid process connected with the scrofulous disease of bone. I am free to say, gentlemen, that I do not agree with Dr. Sayre in his views. Dr. Sayre thinks these processes are due to tuberculous disease of bone. I do not agree with him, but I have great admiration for Dr. Sayre, and I propose to let you have the privilege of listening to his views on this subject." That occasion, Dr. Warren said, had made a strong impression upon him, and he was particularly reminded of it on the present occasion, as he was now standing alongside of Dr.

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Sayre's distinguished successor—his son. It showed how long it took to arrive at a scientific demonstration of certain great truths.

In connection with this discussion it seemed to him proper to make a public announcement of the establishment of a fund, through the generosity of a lady of Boston, lately deceased, for the scientific study of the treatment of such diseases as, up to the present time, are known to be incurable—*i. e.*, cancer, tuberculosis, and similar diseases.

Looking back a great many years in a historical study, the speaker said he had been very much struck with the opinions expressed by the great lights in the profession, such as Hunter and other great men of his time. Hunter and the other surgeons of his day looked upon operative surgery as a reproach to medicine; they regarded it as an inferior department of our art. The reason was that they felt it was a confession that the physicians were unable to cope with disease. At the present time we do not realize, perhaps, the great truth which was brought home to the men of that day, but he was not so sure that in another generation we should get around to the position of our forefathers of a century ago, and possibly through the means offered us by the generous bequest just alluded to. Certainly it was to be hoped that further research would enable us to improve our therapeutic resources to such an extent that these diseases hitherto incurable might be controlled without operative surgery. Dr. Warren said it had been a part of his ambition to found in this school a laboratory for the study of surgical diseases in which processes such as had been explained this evening could be studied from the point of view just indicated. Such a laboratory, he was glad to say, had already been begun in this school. This year, for the first time, under the instruction of Dr. Nichols, a course had been provided in surgical pathology—not a course on tumors, but a course designed especially for the wants of students who are to become house-officers in the surgical wards; a course which confines itself to the practical study of the surgical processes with which they would be brought in contact. Out of this course he hoped eventually to found a surgical laboratory for the experimental study of these different types of surgical disease.

With regard to the problems discussed by Dr. Nichols, the speaker said that one truth had been brought home to us as practical sur-

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geons—namely, the very great extent of tuberculous disease of the bone in all joint affections. There had been a tendency of late years to dwell somewhat more upon the tuberculous affection of the synovial membrane of the joint, and many operations had been devised with reference to meeting disease in that particular locality, such, for example, as erosion of a joint and the excision of the synovial membrane. It seemed to him that these operations left out of consideration the important fact that where there was extensive disease sufficient to entail a surgical operation one was almost inevitably brought in contact with more deeply situated disease. He would lay stress, then, upon the advisability, as a rule, of resorting to the old operation of excision of a joint. He felt that such a demonstration as the one given this evening was not only very interesting from a scientific stand-point, but was of the utmost practical importance.

DR. WILLIAM T. COUNCILMAN, Professor of Pathology in Harvard, said that he had been very much interested in this work of Dr. Nichols as it had developed in the laboratory. It was of a great deal of importance, not only to surgery, but to general medical science, and certainly to pathology. Dr. Nichols had studied an infectious disease (tuberculosis) in a single system of tissues of the body. It seemed possible from knowing the course of the disease, and the sequence with which the various tissues are attacked, that surgery might derive benefit from the work. It would certainly be valuable to the pathologist, because his results were applicable to tuberculosis in other organs.

He would like to say a word concerning the debt which pathology owed to the work which had been done by the surgeons. Strictly speaking, in medical science, there should be no division into surgery, medicine, or pathology—medical science is the same throughout; but pathology as a branch of medical science had been especially benefited by the work that had been done by the surgeons. The very beginning of this was found in the work of John Hunter. He did not know whether the surgeons thought they alone had a right to claim John Hunter; personally, he always spoke of him as John Hunter the *pathologist*, but probably the surgeons spoke of him as John Hunter the *surgeon*. He hardly thought there was any surgeon of to-day who would not consider that the work of this great

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pioneer was of the utmost importance. Certainly the pathologists felt that their first and most fundamental ideas of inflammation came from the work of John Hunter. The work of such men is felt not only in the actual contributions which they make, but in the influence which they exert upon their science. The influence of John Hunter was certainly felt for fifty years afterward. It seemed to him that Virchow might almost be considered the successor of John Hunter, because Virchow was the first one in Germany to cast loose from the various schools of his country and follow the methods of observation and the experiments begun by John Hunter. There could be very little doubt that the work of such men as Waller was largely due to the influence which John Hunter had exerted. The debt which the pathologist owes to John Hunter had certainly been repaid to the other medical sciences by the work of Virchow. Most of the work in surgery which had made German surgery what it is to-day was primarily due to the work of Virchow. Many of these surgeons were originally the assistants in Virchow's laboratory. All of those present this evening were familiar with the work of Billroth, Volkmann, and a host of others. There was just as much work to be done now, following along the line laid down by these great men. The conditions for investigation had somewhat changed, and the questions had somewhat changed. Pathology could derive an enormous amount of benefit from the men engaged in the clinical study of disease. These are the men who know the questions. Pathology can, of course, no longer be considered as merely descriptive pathological anatomy; it has become explanatory science, for the lesions must not only be described, but their mode of origin must be investigated and explained. This could be best done by those who come in direct contact with the sick. Even at the time when Cohnheim made his inaugural address in Leipzig he said that pathology could only be attacked from two points of view—viz.: the clinical and the experimental.

In speaking of the debt which pathology owes to surgeons, one should not overlook the work of Volkmann. His work on tuberculosis of bone was of very material assistance in fixing the infectiousness of tuberculosis, for it had been fully proved before the demonstration of the tubercle bacillus by Koch in 1882. The means for these investigations are not lacking, and the material is always

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present. In almost every city in this country now there are laboratories provided with the necessary means for the modern scientific investigations.

DR. R. H. SAYRE said that he had listened with a great deal of interest to the remarks of the preceding speakers. There could be no doubt that accurate surgical procedures must have their basis in sound pathological anatomy, and he hoped those who had listened to the charming remarks and instructive demonstration this evening would bear in mind that in the future surgery and pathology should be more closely united than they had been in the past.

On motion of Dr. Sayre, the Association tendered a vote of thanks to the various speakers for the very instructive and entertaining remarks.

DR. V. P. GIBNEY, of New York, was asked to speak on behalf of the Association. He said that he wished to express its high appreciation of the excellent demonstration made by Dr. Nichols this evening. He felt that a new light was dawning upon the profession, and that we now had authority for saying, without fear of denial, that tuberculosis of the joints begins invariably in the bone and not in the synovial membrane. This, in itself, would be a great gain for orthopedic surgery; it was an important step toward the early diagnosis of these affections. With improved methods of using the x-ray it was reasonable to hope that tubercular foci could be discovered long before they got into the joints, and that in the future excisions would be seldom performed, and the surgeons would secure better results than a stiff or a peg-leg. He did not wish in any way to belittle the work of those working in mechanico-therapeutics, but he thought it was reasonable to believe that the future had many brilliant therapeutic successes in store. It was possible that by toxins or some similar means these foci could be attacked and destroyed before they had done much damage. Certainly the surgeons would have to look sharply to their laurels in the future.

DR. E. H. BRADFORD, of Boston, said that there was need for the orthopedic surgeon to bestow a portion of his time on scientific investigation. As the President of the Association had stated in his

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address, this Association had done much good work in orthopedic surgery, and had attained a recognized position throughout the surgical world. But the subject of tuberculosis in bone would need all the efforts of the pathologist, of the bacteriologist, and of the surgeon, and all the efforts of the experimenter, before it would be eradicated. It was our business to watch the disease in children, and endeavor to prevent its serious inroads. The demonstration this evening was certainly a long step in that direction.

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ROUND SHOULDERS.

By ROBERT W. LOVETT, M.D.,
BOSTON.

THERE are certain points in connection with the condition commonly known as round shoulders which are not generally noted in speaking of it, to which my attention has been directed by a series of thirty-seven consecutive cases occurring in private practice, where there were good opportunities for observation. Twenty-six of these patients were girls and eleven were boys. These cases have all been of the same general type, differing chiefly in detail, and, although in every respect corresponding to what is ordinarily known as round shoulders, it might seem better, for reasons which will be explained later, in speaking of them to use the more correct term of faulty attitude, which is more in use among teachers of physical training than among medical men.

Round shoulders is, in general, the name given by common consent to a faulty position of standing and sitting, most often described as a condition of adolescence. The attitude is perfectly well known and is familiar to every one. The head is carried not erect but run forward somewhat, the shoulders slope forward, the scapulæ are unduly prominent behind, and the chest appears narrow and flat; such, in a general way, are the most obvious characteristics of this condition.

If any attempt to correct this vicious attitude is made it is generally done by the parents, who put on a peculiar kind of suspender, holding the shoulders back, or sometimes a more elaborate attempt is made by means of some steel or brace devised by the instrument-maker. It is not the common custom to recognize the importance of the condition or to regard surgical advice as necessary.

The affection is not necessarily, as it is usually described, one of

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adolescence, but occurs in young children, for of the series of cases spoken of above, the children were from four to fourteen years old; the majority being from six to ten years old.

The patients in the series alluded to lived mostly in the city and belonged to the better class, where food and hygienic conditions should be good. Twenty-one of these children were brought for consultation because they stooped or protruded their abdomens. Sixteen came for advice because they had "weak ankles," and the round shoulders were mentioned incidentally or not at all. The remaining case came for treatment for a loose semilunar cartilage, and examination showed a well-marked vicious attitude. In certain cases, in my opinion in a large majority of the cases, round shoulders of any considerable degree form only a part of a general faulty attitude, the characteristics of which, it seems to me, are fairly consistent.

Proceeding from the consideration of these cases and others seen in hospital practice the whole class may be described as follows: These children are often thin and generally pale, although occasionally they may be fat and rosy. As a rule, they have grown rapidly. They are most often nervous, active children, and not infrequently they are inclined to constipation. They are generally clumsy in running, inclined to fall easily, and unsteady in their more finely co-ordinated muscular movements; their "balance" is poor. They stand with shoulders drooping and the dorsal spine somewhat rounded backward. If corrected they straighten up wholly or partly for a moment, and then fall back into the original positions. What is equally characteristic with the position of the round shoulders is prominence of the abdomen, which is rarely absent. The lumbar spine is at times curved forward so that the patient stands with an unduly hollow back; at other times the lumbar spine does not differ from the normal curve, but the abdomen protrudes forward in its lower half and the walls seem lax and pendulous. In the severer cases that I have seen an increased forward lumbar curve (lordosis) was present.

If the child is stripped to the hips and examined from in front and behind, some lateral deviation of the trunk is most often noted; it was present to a well-marked degree in twenty of the thirty-seven cases noted above, which were routine examples of round

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shoulders and not ordinary cases of lateral curvature. In the other cases it was absent or very slight. The deviation of the trunk is seen to be due to a slight grade of lateral curvature of the spine, most cases that I have seen having a left lumbar curve with the corresponding slight curve to the right in the dorsal region. In no one of these cases can it be classed as anything more than the very earliest stage of lateral curvature, and in only five had any lateral deviation been suspected. If every child with round shoulders of marked degree were stripped and examined, many cases of lateral curvature would be detected at a stage when treatment is generally satisfactory.

Pronated foot, "weak ankles," is another commonly associated symptom; indeed, so constant is this association that in all children of from four to fourteen years old with weak ankles brought for treatment, it should be made a part of the routine examination to examine the back for round shoulders and scoliosis. This is because "weak ankles" often are only the expression of a general muscular weakness.

There are, then, four elements, most of which or all of which may be found in cases of so-called "round shoulders":

1. Drooping shoulders and prominent scapulæ.
2. Prominent abdomen, with lax walls.
3. Slight lateral deviation of the spine.
4. Pronated foot.

Of course, these are, in practically all cases, merely expressions of the same underlying muscular weakness, and the position is chosen which requires the least muscular effort for its maintenance; this peculiar attitude apparently represents the position of ligamentous support as contrasted with the erect position due to the good muscular balance and proper strength of the muscles.

The treatment should be both local and general. Local treatment should include exercises and, temporarily, support by a brace, if necessary. General treatment should consist in an attempt to reach and correct the essential cause of the muscular weakness.

Local Treatment. The routine treatment generally ordered for these cases consists of exercises prescribed to develop the faulty muscles. In extreme cases, and where the muscles are unable to maintain a better position after a little exercise, temporary support

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is advisable in connection with the exercise. The ordinary apparatus used is a rigid waistband attached to two tempered steel uprights, which hold the shoulders back by axillary straps. In addition to the general developmental exercises some of the special exercises are as follows: backward head bending; backward arm flinging; arch flexions backward. Trunk twisting and similar exercises addressed to the extensor muscles of the spine and to the scapular muscles. Abdominal exercises are given for the weak and flaccid abdominal muscles. The scoliosis requires attention by special exercises, usually unilateral, to develop the muscles on the convex side of the lateral curve. The pronated feet or weak ankles demand a set of exercises devoted especially to the development of the tibialis posticus, the flexor longus hallucis, the short flexors of the foot, and the adductors of the foot. Such exercises consist in rising on tiptoe and separating the heels when standing on tiptoe, and sinking when in this position, walking with the feet in the position of congenital club-foot, that is with the soles facing each other, and similar exercises. The exercises in general should be prescribed with the greatest care and watched most carefully. They should be done once or twice a day, and be followed by a period of rest. The period of treatment is likely to continue over months at least, and any cessation of it before the muscles are properly strengthened is likely to be followed by a return of the faulty attitude.

General Treatment. In my own experience, however, the general treatment of these cases has seemed to me almost as important as the local. As a rule, the children of this class that I have seen have been obviously overworked, and too great demands have been made upon their muscular system, whatever one may say of their nervous system. The life of an active American child living in the city in the upper classes is, as a rule, one of incessant activity. Only too often the noonday nap is discontinued at an early age, and after that from early morning until evening a continuous demand is made upon both muscle and brain. This demand is obviously well met by children of strong and perhaps average mental development; but for growing children not of average strength, with possibly a highly developed nervous system, the demand is too severe, and the muscular system, apparently from over-fatigue, fails to hold

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the trunk in proper position. All sorts of contributory causes come in to effect this and to cause muscular weakness, but no one of the series of cases of which I have spoken has had its origin in severe illness. Where I have asked for a written account of the child's

Faulty attitude from muscular weakness.

daily routine I have found there, it seemed to me, sufficient explanation of the muscular debility in a child of any less than the average muscular strength.

The parents are generally very hard to convince that this is the fact, and particularly resent the use of the very legitimate word overwork. They almost invariably claim that the child's health

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is constantly watched, and that he or she is not allowed to get tired. Nothing less than the detailed account of the daily routine is of any value, when the surgeon may judge for himself. Not only must the daily school routine be followed, but music lessons, dancing lessons, drawing, and similar demands fill up the rest of the day, in the intervals of which the overworked child is encouraged to take exercise and to play out of doors, which, in some cases, is equally contributory to the undesirable result. The following will serve as examples of the state of affairs just spoken of:

CASE I.—A healthy girl, six years old, a child of muscular development rather below the average, was brought to me for well-marked pronated foot. She had had no pain, but got very tired in the feet. Her abdomen was very prominent and her shoulders drooped forward; she had a slight lateral deviation of the spine; she had never had any severe illness, and was considered by the parents perfectly strong. Her pronated feet were corrected by plates, and exercises and massage were ordered for the faulty attitude. She improved rapidly at first, but after awhile the exercises ceased to improve her position in standing, and inquiry as to her routine was made. Her day was as follows:

She got up at 7 A.M., had breakfast at 8 A.M., went to school at 9 A.M., came home at 12.30 P.M., and had her dinner at 1.30 P.M. She then played out of doors till 4.30 P.M., and then played in the house till supper, at 5.30 P.M.; she went to bed at 7 P.M. During this time the mother told me she was practically never quiet unless she was being read to, when she sat still. Here was a day reasonable enough at first glance, but one of unceasing activity and calling for muscular strength for twelve continuous hours.

An hour's rest in the horizontal position was insisted upon early in the afternoon, when the exercises again caused improvement, and the progress has since been favorable.

CASE II.—A boy, eight years old, of apparently average muscular development, had for some months been stooping, and his abdomen was so prominent that his family noticed it. He stood with some slight lateral deviation of the spine, but he had no pronated feet. His routine was as follows:

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Wakes at 6.30 A.M., gets up at 6.45 A.M., breakfasts at 7.45 A.M. Walks or rides on his bicycle to school, a mile away. Gets home at 2.30 P.M., and has had no appetite for dinner. Plays out of the house or in it till 5 P.M., then reads or draws till supper, at 6 P.M., draws again till 7.30 P.M., when he goes to bed. Here was a day of thirteen hours of continuous activity. As an adjunct to treatment by massage and exercise, an hour's rest was ordered, and he left school at 12 M. instead of 2 P.M. Within ten days he was noticed by his family to be standing much better, his lateral deviation has improved, and he stands in an improved position.

CASE III.—This is an example of another type of case where even a modified day's routine proved too much for the individual boy. A boy, ten years old, had been under my care five years before for faulty attitude. His general condition at that time was so poor that a brace was applied, and rest for three or four hours daily was insisted upon. This was followed by exercise, and he made excellent progress. The brace was given up, and I lost sight of him. This year he was brought to me again, standing badly and looking thin and anæmic; he had round shoulders; his abdomen was prominent, and he had a slight scoliosis, but did not have pronated feet. The parents had continued the daily rest and some exercise, but the routine, modified as it was, apparently made too great demand on the boy in his present condition. His daily routine was again amended at my suggestion, and the exercises were increased, with the most gratifying results. There was rapid gain in flesh and color and marked improvement in the faulty attitude. The table shows the changes made:

Daily routine.	Former plan.	Modified plan.
Getting up	7 A.M.	8 A.M.
Breakfast	7.30 A.M.	8.30 A.M.
School	8.30 A.M.	9.30 A.M.
Dinner	1.30 P.M.	1 P.M.
Rest	30 minutes.	30 minutes.
Play	2.30 to 5 P.M.	2 to 4.30 P.M.
Rest	5 to 6.30 P.M.	4.30 to 7 P.M.
Supper	6.30 P.M.	7 P.M.
Bed	8 P.M.	7.30 P.M.

These examples of the daily routine that occupies the time of these children are not, I fancy, exceptional, and they serve only to illustrate what the ordinary children of that class are expected to

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do. But for certain children this is obviously overwork, and overwork which is paid for by nervousness, anæmia, muscular debility, and resulting faulty attitude.

Round shoulders, then, should not necessarily be regarded as a trick which certain children have acquired, and that only an effort on their part is required make them stand and sit straight; but that it is one expression of the condition of muscular weakness which often the children are unable to correct for any length of time on account of poor development of certain muscles.

In addition to the local exercises, the general condition should be rendered as good as possible in every way, and daily work should be avoided.

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THE TREATMENT OF STIFFENED JOINTS BY MEANS OF MECHANICAL EXERCISE.

By E. H. BRADFORD, M.D,
BOSTON.

WITHOUT describing pathological changes, it can be said briefly that under certain conditions joints are stiffened by a lack of elasticity of the capsule and the surrounding ligaments. This results from any condition which produces an infiltration of the tissues surrounding the joint. It is evident that as long as this lack of elasticity persists, stiffness of the joint will remain. If during the acute or subacute stage of an inflammatory condition, whether of traumatic or pathological nature, violence is applied, the condition will be made worse. On the other hand, if the state of inaction be allowed to remain, the condition of lack of elasticity of the capsule will persist, motion being normal in an elastic periarticular tissue. The problem, therefore, in the cure of this affection, when in the convalescent stage, is the application of motion without violence. It is for this reason that passive motion, massage, etc., have been so frequently recommended, and are in some cases of so much benefit. There are also cases where, after the rupture of contracted adhesions, cure has followed gentle motion. It is, however, the experience of every surgeon that in many instances a recovery after brisement forcé does not follow, whether force is applied with or without an anæsthetic.

It is, furthermore, the experience of all surgeons that motion, when applied with violence, excites muscular resistance in the reflex protection of a damaged joint. The condition, therefore, may be described as being one where motion is necessary, but physiological motion is, from the pathological changes, impossible. Massage and gentle passive motion are of use in overcoming this condition, but

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massage and gentle passive motion require skill and judgment and tact to overcome the reflex muscular spasm, which unconsciously resists all attempts in moving a damaged joint. To meet these indications Krukenburg has employed what he terms pendulum appliances, the principle of which may be briefly expressed as the careful use of motion gradually increased, applied to joints with the muscles relaxed, and in such a way that the muscular antagonism is not excited. It is essential that the force used should be graded and applied without sufficient harm to the patient to excite muscular spasm. The apparatus balances the weight of the limb, so that no strain is brought upon the muscles, and uses the swing of the pendulum as the power.

This principle of treatment has been used extensively by Zander, whose writings and work are well known. The work of Krukenburg[1] has not yet been as widely spoken of in this country. The apparatus is advised not only for contracture and joint stiffness, but for all conditions where the circulation should be stimulated.

Although the appliances used by Zander and Krukenberg are excellent, they are not within the reach of many practitioners, and it is for this reason that an apparatus more readily made will be found of value. A slight adaptation enables the surgeon to use this for different joints, or others similar, but smaller, can be made for the smaller joints.

Of the application of the method of treatment, the following case may serve as an illustration:

A delicate woman, aged thirty years, presented herself suffering from a condition of swollen and stiffened knee, suggesting arthritis following injury. A careful examination was made with the radiograph. An x-ray photograph showed that there was no real enlargement of the bone, but that a thickening of the periosteum existed. But little motion of the knee was possible; marked swelling, disturbances of circulation, and stiffness were present. The knee was flexed at an acute angle, and the patient unable to stand. The question of incision was carefully considered, and fixation treatment was attempted, lasting for several months, with some subsidence

[1] Zeitschrift für orthopädische Chirurgie, 1892, Bd. I. Heft i. 14–19. Also in more recent publications.

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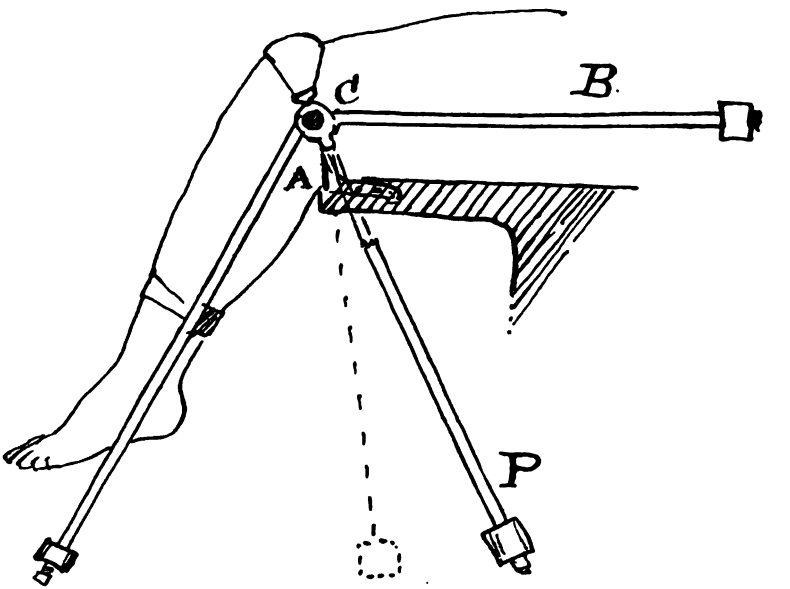
of the acute symptoms, but without improvement in the motion of the knee or use of the limb. It was decided to attempt, in addition to fixation, daily protected and graduated motion, in the expectation that improvement in the local circulation might improve the condition of swelling in the femur. At first, motion was only possible to a few degrees. This gradually increased, and at the end of six months complete motion developed.

No other treatment beyond fixation was applied, with the exception of dry heat, which was used after each daily exercise. The patient at the end of the year was able to walk, using for a greater part of the time a cane as a means of protection.

FIG. 1.



Pendulum appliance or straightening the knee. The pendulum, P, is adjustable at the socket C, where the balanced bar, B, plays on A, attached to a stool.

The accompanying illustration indicates a simple form of pendulum appliance, adapted to a knee. With slight changes it can be used for other joints.

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THE FLEXIBILITY OF THE HUMAN FOOT.

By E. H. BRADFORD, M.D.,
BOSTON.

THE human foot is and has been so commonly distorted by the abuse of footwear that its normal shape and functions are not readily determined. A careful examination of barefooted adults who have never worn shoes is not easily made, but a study of the feet of infants serves as a basis for a conclusion as to the characteristics of the normal foot unaffected by accidental conditions. If the muscluar reflex actions of an infant a few hours' old are closely watched the comparatively extensive movements of the front of the foot are easily seen. These may be the remains of arboreal traits, like a similar condition observed in the hand of the new-born, persistent through many thousand years, or simply natural functions which permit a wonderful adaptability under the varying conditions of future work. If, as a contrast to this, the foot of an elderly individual whose life has been passed in comparative inactivity, with use of shoes compressing the front of the foot, be examined, the amount of injury inflicted upon an organ endowed with great possibilities can be partially estimated. That old age is in many instances enfeebled by the lack of proper care of the feet in early years is so well known that the statement need hardly be made, but it is not so well known in what directions the flexibility of the foot is especially needed, nor in what way the normal functions of the foot are cramped.

The feet of all monkeys, including even the higher primates, such as the gorilla, orang-outang, are practically hands, and prehensile as is essential to arboreal life; but the mechanism of the human foot, even of the oldest human skeletons, shows a structure adapted entirely to erect gait, differing from that of the ape in the relative length of the metatarsals, the shape of the scaphoid,

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the amount of play at the medio-tarsal joint, and in the function of the os calcis. Man is the only animal with an arch to the foot, standing as he does on the os calcis and the metatarsals; but the human

FIG. 1.

Orang-outang walking.

foot retains a vestige of prehensile action, shown clinically in the action of those who, owing to a congenital absence of the arms, or for any purpose, train the feet.

The amount of possible motion in the different articulations as

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determined by the facets of the tarsal and metatarsal bones has been carefully studied.[1]

In this monograph attention will be called to the amount of motion clinically important both in voluntary and involuntary motion.

FIG. 2.

Normal motion in the front of the foot.

One of the most noticeable movements in the front of the normal foot is the abduction of the first toe and its metatarsal, and the abduction of the fifth metatarsal. This can be done voluntarily in infants and in some barefooted individuals to a marked extent; but it becomes much diminished even among children by a few years of the constriction of the front of the foot from shoe wear, and is virtually lost in most adults. It is much greater than is supposed. There is but little or no separation of the second and third and fourth metatarsals from each other. In the adult foot, even when owing to the abuse of shoes, voluntary motion is impossible, owing to the atrophy of the muscles, passive mobility in these directions is possible to a considerable extent (10 degrees).

When the weight is thrown on the front of the foot, as in standing on the front of the foot, the so-called spreading of the foot takes place, including the separation of the toes, as is seen in barefooted people. When, however, the distortion of the great toe has taken place, and bone-changes have occurred, little or no separation of the toes takes place, even when the weight is thrown on the front of the foot. The metatarsals may spread when weight is thrown on the front of the foot, but there is but little or no spread of the toes, as the metatarsal phalangeal articulation is so disturbed that

[1] Voûte Plantaire. Thèse de Paris. Achille Jeanne, 1897.

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this cannot take place. The usefulness and strength of the foot are impaired, and the ankle, weakened by the loss of the support given by the spreading toes, develops the tendency to flat-foot. The adduction and abduction of the great toe are in the primates for prehensile purposes, but in the human being for greater stability.

Plantar flexion of the phalanges upon the metatarsals is possible in an arc of over 90 degrees. An individual with normally flexible feet can place the first and second phalanges at right angles to the metatarsals and the second phalanges nearly at right angles to the first, this being possible as a voluntary motion. Voluntary flexion, and especially extension of the second, third, and fourth toes, is usually less at an early stage among people who wear shoes. If any one examines the sculptured foot of the famous Discobulus, the peculiar position of the toes exerting a force upon the ground, to gain support, is most noticeable, a voluntary contraction which is entirely impossible, to the extent indicated in the statue, by any individual whose feet have been cramped by shoes.

The actual amount of force that can be exerted in an adult in plantar flexion of the toes varies with the size of the toes and the strength of the feet. It may be said that an average force of twenty pounds can be pressed down by the great toe by an individual standing on a firm surface with toes projecting beyond. The amount of strength that can be used by the second toe is much less—not more than five pounds—and this is reduced in the fifth, where the amount of force possible in plantar flexion is not more than one pound. It is impossible to determine the amount of force which can be used in flexing the metatarsals alone, as it is not possible for any individual to make this motion voluntarily, a motion assumed in certain attitudes of the foot.

The amount of rotation at the medio-tarsal articulation varies greatly. In the Burmese idols where the Buddha is represented as seated cross-legged, it is not infrequent for the soles of the feet to be depicted as facing directly upward. People who have never worn shoes will be seen who can fold one foot upon the other as readily as the hands are folded upon each other. This extent of medio-tarsal flexibility is, however, never seen outside of infancy in individuals who have worn shoes, and has no clinical importance, but it is of importance to determine the arc of move-

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ment at the medio-tarsal articulations within which a limitation may be considered pathological. This may be placed at an arc of 30 degrees. Motion greater than this is by no means uncommon. Motion less than this may be considered as interfering with the true usefulness of the foot in normal occupations.

Limitation in the adduction of the first metatarsal is frequently seen, and can hardly be said to cause noticeable inconvenience except to individuals whose activity leads them to rely on the rapidity of gait. It does, however, produce a tendency to the development of flat-foot, in removing one of the supports which nature has intended to check the valgus position of the tarsals. The abduction of the fifth metatarsal and toe as it is seen commonly in infants, if it persists in adult life in those who have worn shoes, is to so slight a degree that the angle of motion can often not be noted. When normal it serves to prevent the so-called turning of the ankle.

One of the common losses of flexion is at the metatarsal phalangeal articulation. It is surprising to note the extent to which this may be developed without causing sufficient injury to demand treatment. Individuals will be seen who, for a large portion of their lives, have walked without throwing any weight upon the end of their phalanges, even that of the first toe. It is not uncommon to see individuals with an anchylosis at this articulation, and in some instances with an anchylosis at an angle, so that no weight falls upon the ball of the toe, the weight coming chiefly upon the terminal phalanx, the metatarsal phalangeal articulation being forced upward.

It is probable that the deformity which is known as flattening of the transverse arch is in part due to the fact that none of the weight is thrown upon the phalanges of the first toe in the push of the foot in locomotion, and that the transverse arch results from a forcing upward of the head of the first metatarsal. A study of the callosities of the feet is useful in indicating the points of greatest strain and pressure. They will usually be found on the ball of the great toe, beneath the heads of the metatarsal bones, and often on the under side of the great and other toes, and under the os calcis, as well as under the outer edge of the foot; but in flattening of the transverse arch, callosities will be found under the second and third metatarsal heads.

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Where motion is limited in the different joints below the normal degree, locomotion is less free than normally should be the case. Locomotion, however, is possible without great discomfort, even if there is great stiffness in the smaller joints, provided the tibio-astragaloid articulation is free.

It is, however, manifestly desirable that the normal motion of the different smaller joints be established, as disability exists in proportion to joint stiffness. This can in some cases be done by the use of force, but this means cannot be permanently beneficial unless accompanied by general daily exercises re-establishing the elasticity of the joint tissues. Massage and gymnastic exercises are of a certain amount of use, but are rarely carried out with such thoroughness as to be beneficial in resistant cases.

Mechanical exercises will be found to be of use in developing the motion at the metatarsal joints. These can be of simple construction, and will be found applicable to the feet of children or young adults, if persisted in daily for weeks or months. It is manifest that this cannot be obtained in case of the presence of exostoses, and it is self-evident that nothing can be done in the way of treatment, provided the toes continue to be crowded by shoes that are too narrow for the normal spreading of the foot.

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CONGENITAL DISLOCATION OF THE HIP JOINT.

By E. H. BRADFORD, M.D.,
BOSTON.

At the presentation of the subject of congenital dislocation of the hip before the Congress of American Physicians and Surgeons a year ago, the statement was made, in the discussion which followed, that operative, interference in these cases is hardly justified in view of the fact that patients with congenital dislocation suffered but slightly in after life.

In this connection the report of the following cases may be of interest.

Case I.—An active, strong woman, sixty years of age, with congenital dislocation of the right hip, the mother of four children, for whom she has kept house during an active life. For three years during adolescence she was obliged to wear crutches after she attained to adult growth. For a number of years she was obliged to use a cane constantly, and she has not been free from some pain on walking a distance over a mile during the course of her life. The pain has not been severe, and has not prevented her doing housework or engaging in ordinary occupations, but has prevented her locomotion beyond a certain range.

Case II.—A feeble woman, forty-five years of age, with double congenital dislocation of the hip. Has done sewing, is incapacitated for active work, and, owing to poverty, is obliged to enter an almshouse or be supported by a charitable friend, as her relatives have either died or are unable to maintain her support.

Case III.—Healthy woman, thirty-five years of age, with single congenital dislocation of the right hip, is engaged in a sisterhood as

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a sister, and is able to attend to the lighter work of her sisterhood. She walks with a slight limp; was taken with a severe attack of pain, which was located in the muscles around the hip. The pain was so severe that she was obliged to remain in bed and to use her crutches for two weeks, after which a recovery was made. Has had similar attacks occasionally.

CASE IV.—Delicate young woman, twenty-five years of age, with severe pain in hip and limb from a congenital dislocation of the left hip. The patient has had much care in the nursing of a relative; has broken down in strength, locomotion is painful, and crutches have been used for six months, after which improvement took place, so that crutches were laid aside.

CASE V.—Healthy, active young lady, twenty-five years of age, with a congenital dislocation of the right hip joint, complained of no symptoms except the limitation of the range of her walking capacity, being unable to walk farther than a mile without muscular pain and fatigue about the hip.

In none of the cases was the disability accompanied by a severe lateral curve of the spine. In all the limp present was considerable.

The past year's experience has also shown that in many cases where reduction has been made by the method of forcible reduction a relapse has taken place. In certain instances this is apparently due to the fact that the cotyloid ring is not large enough for the entrance of the head of the femur. If the head does not pass through the cotyloid ring, and the cotyloid ligament lies in front of the head rather than around the neck, complete reduction has not taken place. By wear and tear and retention of the head of the femur in the proper place, it is thought that absorption of the cotyloid ligament will take place to a sufficient degree to allow an adjustment of the parts to a normal condition. The accompanying case illustrates the condition described, where the opening in the cotyloid ring was too small for the entrance of the head, and where operative interference was necessary.

The case is of a child, three years of age, with double congenital dislocation of the hip. Reduction by forcible correction was easily

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FIG. 1.

Specimen of congenital dislocation of the hip-joint. Warren Museum.

Right hip joint corrected by forcible manipulation with temporary success, but subsequent relapse; the specimen shows that the cotyloid ring is small and the tissues strong and thick, resisting all attempts to pass the head through the ring, which is pushed before the larger head. The tissue is too tough to justify a belief that it will be worn through by any pressure of the head upon it in locomotion.

made, and the hips were fixed with plaster-of-Paris in an abducted and inverted position. This was continued for a month, but on a second examination it was found that a relapse had taken place and that the hips were not firmly placed in the sockets. The right hip

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was, therefore, cut down upon. The ring of the cotyloid ligament was found to be too small for the entrance of the head, being not more than a quarter of an inch in diameter. This was dilated, the head passed through, the wound stitched, and the patient recovered. Three months after the operation the patient was attacked with whooping-cough and died. At the autopsy an opportunity was made to examine both hips, both the one that had been reduced by forcible manipulation, and the other where an incision had been subsequently made. The condition is shown in the accompanying illustration.

It will be seen that in the hip which had been reduced by forcible manipulation, the condition is not that of an ordinary, untreated congenital dislocation. The capsule is near the joint, and the head of the femur is placed near the normal condition. A complete correction, however, has not taken place, and the cotyloid ligament is between the head of the femur and the acetabulum. This is not the case with the hip which had been cut down upon and treated by open incision, where reduction is complete. In many instances where relapse after forcible correction is reported, a condition similar to the one here described is probable; but this cannot be the rule, as in many instances permanent cure is reported to be the result. Relapse may take place after any method of correction, through neglect of preventing eversion of the foot, owing to a twist of the neck of the femur in the relation of its long axis to the cross axis of the shaft of the femur, resulting from the congenital deformity. If the foot of the corrected limb is slightly turned out, the head of the femur is thrown forward and in front of the acetabulum.

The tendency to relapse will be minimized in after-treatment by fixing the limb in a convalescent stage in a strongly inverted position, and by continuing this position for several months of locomotion. In addition to this it is desirable, if the neck is short, that the legs should be abducted, in order to hold the head in apposition to the acetabulum. This should be carried out for at least six months. It is essential that immediately after forcible reduction the limb should also be held abducted and inverted. This can be readily done by means of plaster-of-Paris, but a double Thomas splint arranged with abduction is a more convenient means of fixation, and can be made equally effective. Where the patient walks about, in single dislocation of the hip, a single Thomas splint

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arranged to fix the limb in an abducted position, with a high sole upon the other limb, is of use for a while. Later a walking splint can be made, turning the foot in, but without abduction.

FIG. 2.

Left hip joint, reduced under forcible manipulation. It relapsed; subsequently operated upon by open incision. The head passed through the dilated cotyloid ring; the acetabulum was found large, and the reduction remained firm. The child recovered entirely, but died several months later from whooping-cough.

Where an operation is decided upon, careful attention to anatomical details is necessary. Where the resistance is particularly great the

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operation should be divided into two stages, and carried out in two sittings, if necessary. The first is that of stretching and overcoming all muscular contraction. This is done either by manual stretching or by the use of a windlass attachment, with a long arm fastened to a ring-splint enclosing the thigh and pressing upon the perineum. This should be applied and a gradual stretching carried out under an anæsthetic. The hamstring tendons can be divided subcutaneously and the ilio-tibial ligament cut some distance above the tibia. The tensor vaginæ femoris should also be divided subcutaneously, and it is desirable to divide the insertion of the great adductor.

Where sufficient stretching is not gained in this way the insertion of the tensor vaginæ femoris and of the pelvic attachment to the rectum can be freed by a small open incision and the use of a periosteum elevator. The adductors can also be divided by an open incision. Under gradual stretching, both in a longitudinal direction and in forced abduction, the limb can be brought into such position, and the head can either be reduced or nearly reduced. The question then remains whether the capsule should be divided or not. This is a matter of judgment, dependent upon anatomical conditions and the skill of the surgeon in passing the head through the cotyloid ring.

Where it is decided to cut down upon the capsule an oblique incision in front of the gluteus medius should be made, passing from the anterior-superior spine outward and downward, crossing the femur. The incision can be made between the tensor vaginæ femoris and the gluteus medius. The dissection should be rapidly made down to the capsule. As soon as the capsule is reached it should be cleared, opened, and cut obliquely across. It is then desirable to find the trochanter minor, and all capsular or ligamentous attachments which retain the head in the distorted position should be entirely freed. After this is done the head is put in through the cotyloid ring into the acetabulum. If the ring is not large enough, it can be dilated by a divulser or cut by a herniotomy knife.

The freeing of the capsular and ligamentous attachments can be done by means of stretching, and periosteum elevator and dissection, and should be thorough, so that the head can be placed well in the acetabulum, remaining so in every position of the limb.

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FIG. 3.

Skiagraph of a case of congenital dislocation of the hip one year after reduction by open incision.

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The strictest asepsis is demanded, as the wound is a deep one and drainage not easily complete. Furthermore, the joint cavity opened is a rudimentary one and incapable of the ready absorption of retained blood secondary to operative interference.

In the cases operated upon by the writer during the last year, it has not been necessary to enlarge the acetabulum if the head is well passed through the cotyloid ring.

In all the specimens of congenital dislocation at the Warren Museum the acetabulum is of normal size.

DISCUSSION.

DR. ROYAL WHITMAN said that he was in accord with the reader of the paper in urging the positive treatment of congenital displacement of the hip by replacement.

He would, however, call attention to the great advantage of the Lorenz method of forcible reposition in selected cases, at least as a preliminary to the open incision. He was of the opinion that the obstacles to successful reposition, described by the reader, were, to a great extent, secondary changes that did not exist at an earlier age. The great advantage of the Lorenz operation was the fact that one might readily obtain the consent of parents to an operation that did not require cutting, or confinement to a hospital, even in infancy, while the open operation must often be deferred till later childhood.

He had operated on seventeen children by this method, and was able to report several successes. One of the patients had been presented at the New York Academy of Medicine, showing absolutely no trace of the former disability.

Another point in favor of forcible reduction was that, even if it were unsuccessful, it was still of advantage, because it made the secondary operation by open incision much simpler, and the after-treatment shorter, because of the improvement in the attitude induced by the supporting plaster bandage. Even in the unsuccessful cases it was always possible by the forcible manipulation to overcome the shortening and the contraction of the muscles, and to change the posterior into an anterior displacement, bringing the head of the bone into close proximity to its normal situation.

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Thus far he had been obliged to perform the secondary open operation in but two of the seventeen cases; and although he did not anticipate more than 50 per cent. of cures by the method of forcible correction, even in selected cases, yet he thought it should be attempted in every case under the age of four years at least, the open operation being reserved for the failures in reposition and for the older and more difficult cases.

DR. GIBNEY said he had been impressed with Dr. Bradford's zeal in these cases, but personally he had been much discouraged at times. He had encountered the obstacles that Dr. Bradford had described. For this reason he had welcomed the bloodless method, and while he had no absolutely perfect results yet to show, he felt that enough time had not elapsed, and that as the cases could be treated at a much earlier age, the prospect of getting a good result was much better than heretofore. In his earlier operations he had been desperate enough on two or three occasions to dissect the whole capsular ligament out of the way, but such extensive operations had been followed by high temperatures, and the ultimate condition had been, if anything, worse than before. The inventor of the operation himself seemed to have obtained the worst of all the results yet reported. He did not say this to criticise the operator, but simply to show how bad results might follow the operation even in the most skilful hands. The case upon which Hoffa had operated now had a shortening of three or four inches. He disliked very much to see a child over five years of age with such a dislocation untreated. Even where forcible correction had resulted in an anterior instead of a posterior dislocation, the children seemed to walk better.

DR. SHAFFER said that he had had no personal experience with these operations, although he had seen and followed for a long time a good many cases of congenital dislocation. One of these was a child upon whom Dr. Sands and he had attempted twenty years ago to make a forcible reduction. The child was at that time about five years of age, and the manipulations were made under ether, but the reduction of the dislocation had not been effected. He had then applied a traction splint, and kept the child under observation for

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about a year. At the end of that time he was surprised to find that the child had a stable joint. At the present time this patient, now a young lady, walks well with a scarcely perceptible limp. Other similar cases had recovered. With these results in mind at present he would not feel disposed to subject a child to an open operation for congenital dislocation of the hip. And he finds others, good observers, who have the same opinion. Perhaps, if a complete tabular statement of the real and permanent results obtained so far were published, it might raise a doubt as to whether the operation is justifiable. Nevertheless, he wished to thank Dr. Bradford for his very able presentation of the subject, and to commend his perseverance in it in face of so many obstacles.

DR. RIDLON said that during the past eight months he had succeeded in reducing three cases without cutting. The bones are still in place and still in plaster. Their ages were between two and three years. He had three times attempted reduction in a girl of eleven years. Each time he had got the "click," but in each instance the head slipped out in spite of plaster-of-Paris.

DR. BRADFORD closed the discussion. He stated that he did not wish to say anything against the bloodless method except that it was not always certain. If Dr. Whitman had examined a specimen in the possession of Dr. Nichols he thought he would agree that an important obstacle was the cotyloid ring. He believed now that in children under five years it was possible to keep the bone in place. The operation is not a dangerous one as at present performed, and the disability in cases not operated upon is certain; hence the operation seemed to him perfectly justifiable.

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THE FUNCTIONAL IMPROVEMENT IN PARTIAL PARALYSIS OF THE HAND AND FOOT.

By O. VULPIUS, M.D.,
HEIDELBERG, GERMANY.

Paralysis from central origin cannot be cured if the corresponding centres are irreparably destroyed. Our task must begin as soon as possible after the inception of such a malady—that is, immediately following the acute period, in order to assist the nutrition of the muscular tissues and to protect them from atrophy through non-use. The muscles which have been deprived of their centres cannot be saved; but we can often obtain partial usefulness of a paretic extremity by means of timely and energetic massage, electricity, hydropathy, gymnastics, all of which may be of the greatest importance for the functional activity of the limb.

It is true that this remnant of muscular tissue at times and under certain circumstances has an injurious effect on the position of the paralyzed joints. By the wasting of the antagonists they become contracted, and, through shrinkage of the soft parts and the formation of bony deposits, get fixed. Thus we may explain paralytic club-foot and flat-foot; thus abduction of the hand and claw-fingers.

After the restoration of the muscles the limb should not be left alone if we want to prevent later deformities. It is true that the operation for anchylosis (arthrodesis) may prevent this; but we thus should lose all the muscular force. Another method would be to keep up the motion in the joints by means of mechanical apparatus. This can only be done by the most perfect, and, therefore, expensive apparatus, and the continual repairs would be most annoying for the patient. It seems impossible also to construct a practical apparatus for the motion of the hand and fingers, the most important of our joints, as an individual may live and work with a pes valgus, while the paralyzed hand renders him helpless.

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The transplantation of tendons, an operation already introduced fifteen years ago by Nicoladoni, but meeting with but little success at the time, seems to be destined to help these cases. The leading idea of this operation is to localize the seat of muscular force fittingly by guiding it over functionally important tendons. Sound muscles with comparatively unimportant functions may be entirely used for the re-establishment of an important motion. Muscles with important functions must not be completely interrupted in their continuity, but a part of their tendon can be used for transplantation.

The technique of transplantation is quite simple, but the preceding construction of the operative plan is more difficult. Sometimes we have to divide one muscle into several tendons, at other times join several individual muscles for a combined functional action.

Extensive longitudinal incisions in the limb (previously made anæmic) expose the tendons in order to split or completely sever them. Now follows the transposition of tendons, which ought to be done subfacial, if possible, in order to favor the production of new tendon-sheaths and to prevent cicatricial fixation to the subcutaneous adipose tissue. After approximating the tendons they are sewed together with as much tension as possible, pulling the conductors of force in a centrifugal, the receiver of force in a centripetal direction. An interbraiding of the tendons through small incisions into their substance secures the fixation of the *silk* sutures.

Of the many methods which can be used for transplantation, briefly sketched by me in No. 197 of the new series of Volkmann's *Clinical Lectures*, the so-called descending method seems to me the most practical. With this method the force-conductor is transposed centrifugally and united with the uninjured paralyzed tendon. After closing the external wound and covering it with an aseptic dressing, the plaster-of-Paris bandage is put right over it. If we have to deal with a fixed deformity it should be first removed by means of the modelling redressement, the transplantation follows with the plaster-of-Paris bandage in hypercorrected position. In about six to eight weeks one commences the after-treatment, with massage, electricity, and exercises as soon as pos-

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sible. The influence of these remedies not only on the muscles, but also on their innervation, cannot be denied.

Looking over the literature on this subject I notice that up to last year not more than thirty cases have been published, among them also some interesting American observations. My own experience brings the whole number of known transplantations up to eighty or ninety. It is sufficiently large to permit a decision on the value of this method and to predict a steadily growing appreciation in the medical world. Successes have been reported by all operators, and it cannot be doubted that with further improvements of the method and a correct selection of cases the results will still be more favorable.[1] Until lately the transplantations of tendons were only made for the paretic muscles of the leg, for paralysis and paretic deformities of the foot. Only twice I undertook to replace the quadriceps femoris. It has been tried recently to help the hand and fingers, and although very few reports have been published, the results have been good.

Each, Drobnick and Krynski, report such a case; the latter, as well as Kirsch, had to deal with traumatic defects of tendons. Franke strongly advocated, in 1897, the transplantation of tendons after operating on two cases of paralysis of the radial nerve. In the *Lyon Médical*, 1897, No. 34, Rochet, of that city, reports four most interesting cases where he very skilfully transplanted the tendons on the forearm with a very promising result.

I can only add two new cases myself, where I grafted half of the flexor carpi radialis on the paralyzed flexor digitorum profundus, and thereby gained at least some possibility of flexion.

We certainly have here an extensive field of gratifying work before us, where we may bring help in cases that were formerly pronounced incurable.

[1] After writing this essay I learn that this has been verified for America, where a very important paper on this subject has been read in the meeting of the American Association of Orthopedic Surgeons in 1897.

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ON THE TREATMENT OF THE KYPHOSIS IN POTT'S DISEASE.

By P. REDARD, M.D.,
PARIS.

I AM an absolute partisan of the method of rapid reduction at a single sitting of certain of the kyphoses occurring in Pott's disease.

The practice for more than a year with this operation has furnished one hundred and twenty case of reductions of Pott's deformity, and has established the conviction in my mind that this method, applied with prudence and under certain conditions, is practical, efficacious, and exempt from danger.

All Pott's deformities are not suitable for reduction. Kyphoses which are more or less easily reduced by light traction at either extremity of the trunk, or by slight pressure on the boss, may be corrected without danger. The correction of irreducible, anchylosed kyphoses is subject to serious complications. We do not advise the operation in such cases. The reduction is indicated for the reducible kyphoses of short radius and of rapid development and for those complicated by paraplegia of sudden onset.

The age, the degree of deformity, its size and extent are not counter-indications to the reduction of the deformity.

The failure to reduce the deformity by the application of force and moderate traction is the only factor which, in our opinion, should determine whether a case ought to be operated upon.

Bad general condition, diffuse tuberculous changes, visceral diseases, large cold abscesses are the counter-indications for operation.

The technique of our operation consists in obtaining the reduction without roughness or violence. We are absolutely opposed to the employment of violence or roughness in the reduction.

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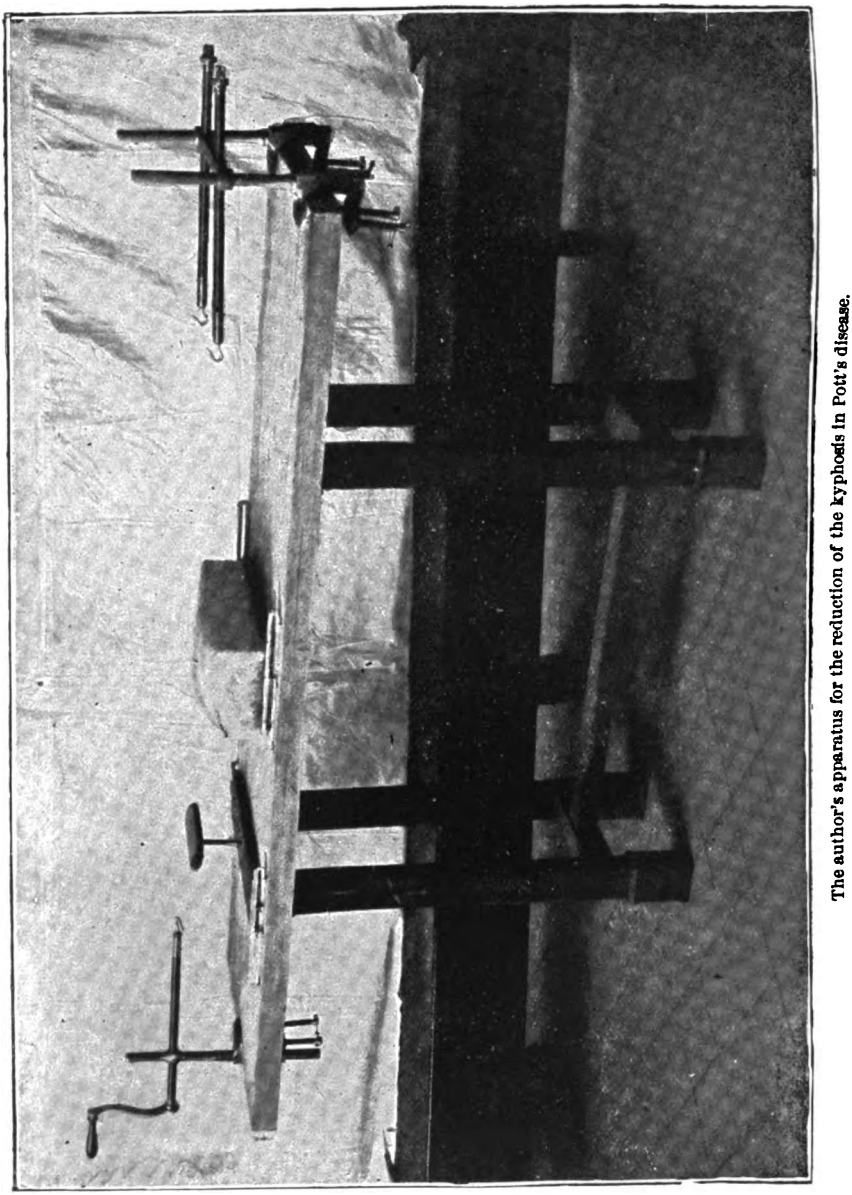

Fig. 1.

The author's apparatus for the reduction of the kyphosis in Pott's disease.

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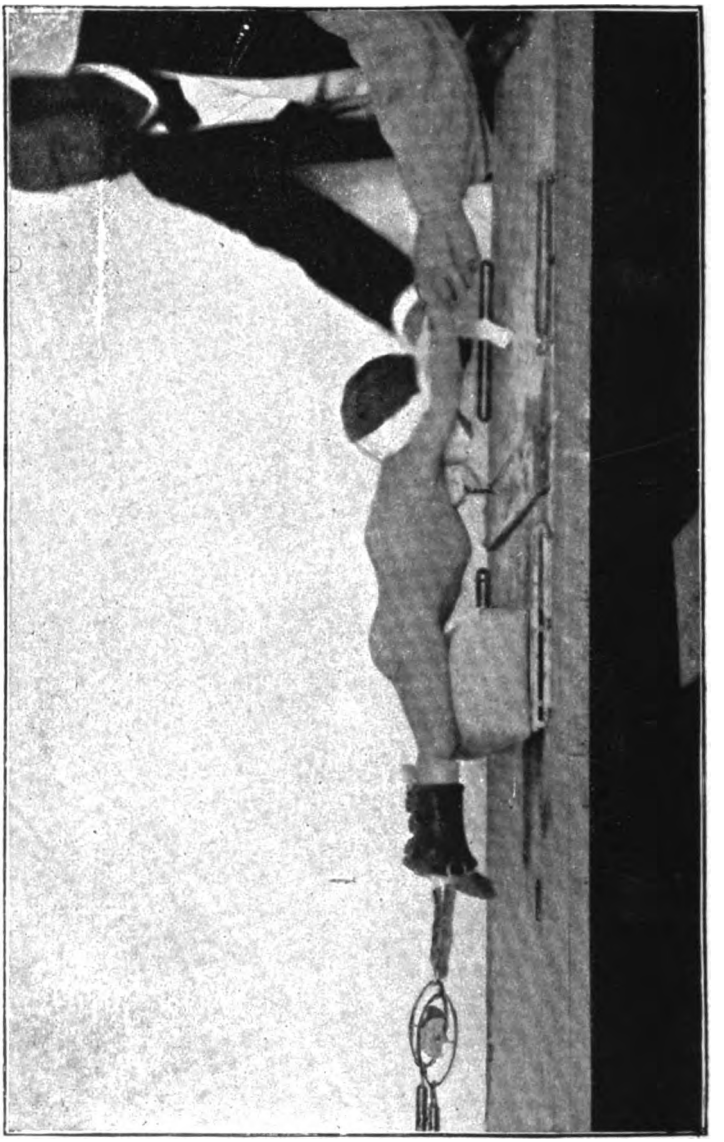

FIG. 2.

Kyphosis before reduction. Two years' standing.

We have for a long time employed in the operation an apparatus such as is represented in Figs. 1, 2, and 3. This apparatus reduces the kyphosis by means of tractions which extend the

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FIG. 3. Same case as Fig. 2, after reduction by the author's apparatus.

trunk, the force for which is applied through screws acting on the lower extremities and head, as indicated in our figures. The force employed is sufficiently powerful, but is applied gradually

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and gently, in a measured way, and may be continued a considerable time steadily and without jerking or roughness. The complete reduction of the kyphosis is almost always accomplished at a single sitting by using our apparatus, without which it would be necessary to exert direct pressure on the kyphos.

Our apparatus almost completely does away with the necessity for assistants in the application of the plaster apparatus easily and correctly, by avoiding prolonged manual compression during the setting of the plaster.

Pain during reduction with our method is very trifling, so that the use of chloroform may be dispensed with in the reduction of deformities of moderate severity.

After the reduction we use a complete plaster apparatus for the trunk and head. We apply our plaster bandages directly on the skin, using in some cases a swathe or a very small quantity of wadding.

Our experience has satisfied us that too large a quantity of wadding applied to the trunk beneath the plaster does not permit of a good reduction of the kyphos, but favors its reproduction and exposes the angle of the badly-reduced kyphos to chafing and the formation of pressure-sores.

If the plaster apparatus in inclosing the trunk is well applied, the correction of the curve is exactly maintained and the head portion of the apparatus may be dispensed with, especially in cases of lumbar and low dorsal deformity.

In our statistics, comprising forty cases of reduction in deformities of varying severity and duration, we have not noticed either primary or secondary complications. We have observed many cases of Pott's deformity absolutely corrected. The kyphosis has completely disappeared and the spine is rigid and consolidated. The prolonged immobilization in the corrected position in our apparatus is favorable to the cure of Pott's disease.

In conclusion, the rapid reduction of the kyphosis in Pott's disease is a therapeutic measure of very great value, and renders important service in a great number of cases.

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FORCIBLE REDUCTION IN THE TREATMENT OF SCOLIOSIS.

By P. REDARD, M.D.,
PARIS.

For two years we have adopted the method of forcible reduction for the treatment of numerous cases of scoliosis. The technique of the operation is of considerable importance, and we shall lay particular stress on that point in this communication. We will describe the perfected technique which we now employ. The operation of forcible correction by which, at a single sitting, the shape of the prominence and the scoliotic curve can be corrected, must be modified according to the shape of the deformity and its duration, as well as according to the degree of flexibility or rigidity of the spine. When the curvature is rigid and resists the manipulations for correction, it is necessary to recommend a preparatory treatment which has for its object mobilizing and softening.

Besides the orthopedic exercises for suspension, manipulations for correction are very useful in these cases; we recommend firm, continuous pressure obtained by means of an India-rubber band acting on the prominent point of the deformity, according to the arrangement shown in Fig. 1 of our apparatus. Figs. 1 and 2 show the detail and the mode of application of the apparatus, which should be placed on a solid table, the patient lying horizontally upon this.

This firm, elastic pressure, acting on the most prominent part of the deformity, modifies not only the shape of the dorsal prominence and of the thorax, but mobilizes and corrects the curves of the spine. The exercise of pressure at the level of the exaggerated curve of the thorax acts by reducing the antero-posterior diameter and increasing the lateral diameter.

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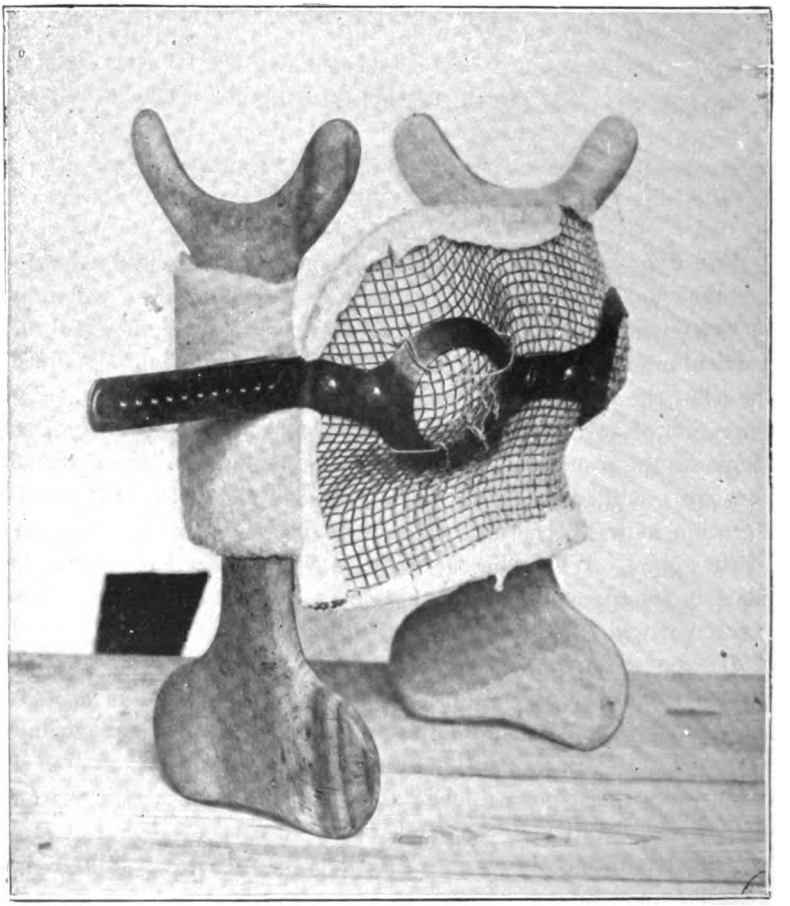
By the frequent application, many times a day, of the apparatus, for fifteen minutes at a sitting, one can obtain rapidly a mobilization and reduction of rigid scoliotic curves, a modification

FIG. 1.



Elastic-pressure apparatus for the preparatory treatment of forcible reduction.

favorable to the shape of the dorsal deformity and to that of the thorax.

The use of the apparatus is easily borne without much pain, and without interfering with respiration, on account of the breast-

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plate of iron-wire which protects the breasts in front and takes all the pressure at this point.

Fig. 2.

Application of the apparatus shown in Fig. 1.

The lateral supports take hold in the sides of the pelvis and in the axillæ. They project backward, and are so arranged that the pressure is exerted only in the most effective manner. The

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preparatory treatment is frequently indicated, particularly when the scoliosis is pronounced, of long standing, with rigid accentuated curves.

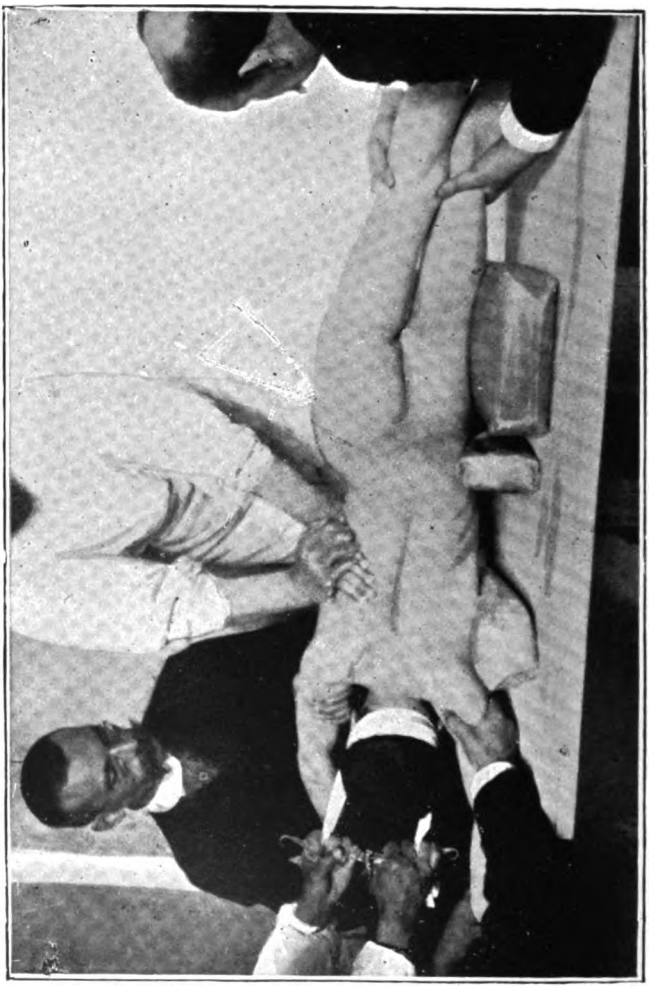

FIG. 8.

Manual forcible reduction of scoliosis.

The forcible reduction is accomplished, the patient being anæsthetized, by firm traction at either end of the spinal column, combined with pressure at the level of the deformity.

In some cases this forcible manual reduction is enough. It must be used as indicated in Fig. 3.

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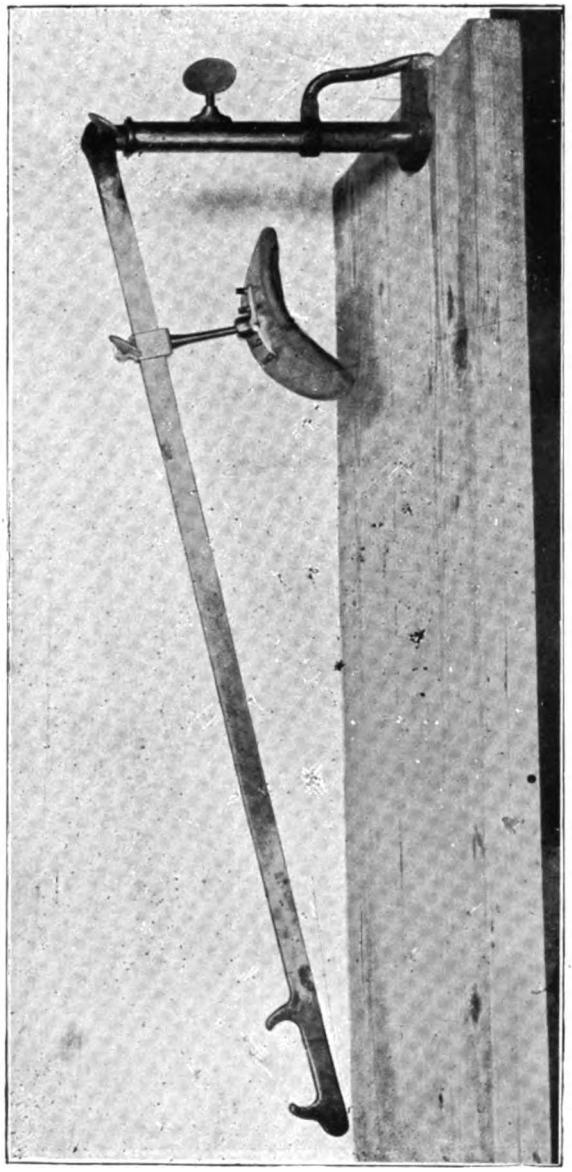

FIG. 4.

Lever apparatus for forced instrumental straightening of curvature of the spine.

Energetic pressure ought to be maintained during a certain time up to the moment the spine is mobile and easily reduced like the other side.

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FIG. 5.

Application of the lever apparatus for straightening curvature of the spine.

In all our operations we commence with the forcible manual reduction, using our method of forcible instrumental reduction only when the results by the first method are not satisfactory.

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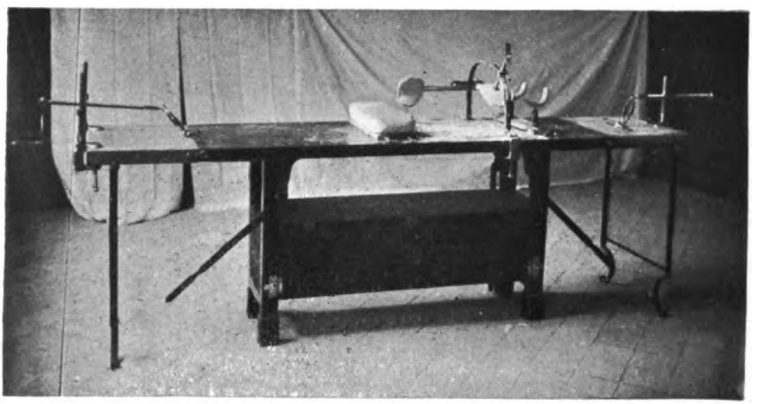
In this method the patient is placed as in Fig. 3 ; a concave cushion fastened to the long arm of a lever, according to the arrangement indicated in Figs. 4 and 5, permits the exercise of very strong pressure directly on the deformity, changing its shape and mobilizing it, also correcting the curvature.

In the last way we place the patient prone on the table, with a cushion beneath the pelvis and one beneath the sternum. Traction, measured by dynamometers, is exerted at the head and feet, Figs. 6 and 7. The traction is made gradually, without exceeding forty or fifty kilogrammes, up to the point when the curve is well reduced. During extension with our apparatus strong traction is exerted by assistants at the limbs.

FIG. 6.



Apparatus for forcible reduction in treatment of scoliosis.

In order to maintain the reduction of the rotation and lateral coordination, we bring the pressure to bear by means of a mobile, concave cushion which is fixed to a metallic arc fastened to the operating-table. The cushion, moved by a screw in the end, presses on the gibbus in a direction which is determined upon by the diagonal diameter of the thorax. The counter-pressure is obtained by means of a metallic body fixed to the metallic arc of the other side, and is fastened up by a crutch placed under the arm-pit, and down by a metallic plate which has its point of support on the pelvis.

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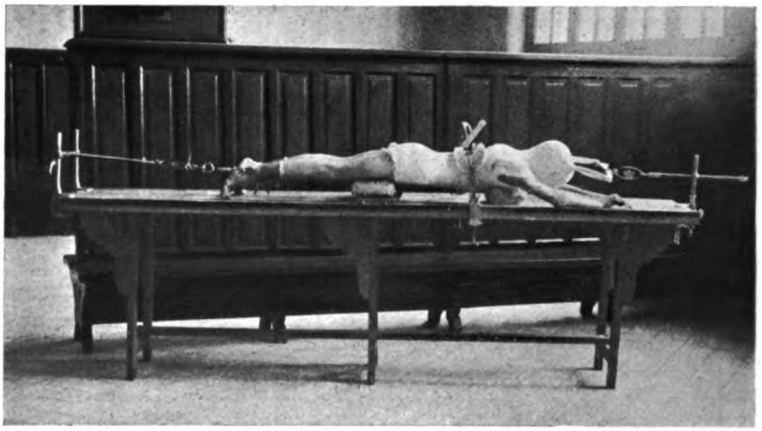
This body, by means of the screws in the end, can be widened or narrowed according to the needs of the case. Figs. 6 and 7 indicate the position and the mode of application of this apparatus. Fig. 7 shows the way in which the pressure may be managed. When the apparatus is regulated, the force exerted in the proper direction, and the curvature reduced, we then raise the metallic arc and apply the plaster apparatus; the plaster apparatus being completed, the arc, with its accessories, is again lowered, the cushion pressing on the plaster at the level of the deformity, and the pressure of the reduction being maintained throughout the time required by the plaster in setting. (Fig. 7.) The plaster apparatus incloses the head and trunk (Fig. 7), and is intended to control the scoliosis after its reduction, as it seems best to us.

FIG. 7.



Position and mode of application.

The thoracic part of the apparatus must be applied during the extension in the horizontal position; the cephalic portion during vertical suspension.

The time required for a cure by the method of forcible reduction varies according to the seriousness of the case and its duration. Several sittings at intervals of from two to four months are often necessary. The cure is generally obtained quite rapidly. The patient endures admirably the long sittings of the forcible reduction

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under chloroform. We have never had an accident of any sort. The respiration continues regular, subject, of course, to a momentary cessation at the time of the application of strong pressure on the thorax. The most careful watch should be kept at that time.

According to our experience in the application of forcible correction, this method is best in the rhachitic scolioses and those occurring in adolescence which have resisted protracted orthopedic treatment.

It is of the greatest value in deformities of rapid development which present many curves and marked costal deformities. It is also applicable to the reducible or moderately rigid curves. In these cases it gives us the reduction of the scoliotic curves and produces changes which favorably influence the prominence of the "gibbosités." It corrects the faulty inclinations of the spine, but acts very little on the deformity dependent on the rotation of the vertebræ. Even in the long-standing rigid cases, with anchylosed vertebræ and pronounced costal deformity, the reduction according to our technique is capable of notably ameliorating the condition.

In our estimation the method of forcible reduction gives a cure or an improvement in a great number of cases which could not be obtained by the customary methods of treatment.

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CHILDREN'S ORTHOPÆDIC WARD, AGNEW MEMORIAL PAVILION, UNIVERSITY HOSPITAL, SPECIAL EQUIPMENT.

By De FOREST WILLARD, M.D.,
PHILADELPHIA.

A DESCRIPTION of a few of the special items of equipment of this ward may be of interest to the Association.

BUILDING. First, the building is erected so as to secure the benefit of the east, south, and west sun. The windows are large (double in winter for protection), and the ward being but thirty feet wide, the sun streams across it all day. Decided benefit is thus secured against "hospitalism" in patients confined to bed.

The ward has tiled sides and open fireplaces.

VENTILATION. Ventilation and excellent circulation of air are secured by open gratings beneath each bed, connected with a hot-air shaft which by forcible suction constantly carries off the heavy and deleterious gases.

SUN-PORCH AND PLAYROOM. The sun-porch is an important feature. It is at the southern extremity of the building, and opens directly from the ward by a wide door without a sill. The beds are supplied with three-inch rubber-tired wheels and are easily rolled out upon this porch. It is enclosed with glass and heated in winter, open in summer, and looks out upon green grass, trees, and pleasant surroundings. The bed-ridden patients look upon this retreat as their greatest privilege. It is occupied for three hundred and sixty-five days in the year either by bed patients or as a playroom for convalescents. (Fig. 1.)

TROLLEY SUSPENSION. Extending the entire length of the ceiling of the main ward is a trolley track from which is suspended an adjustable leather corset travelling on overhead wheels. In this a child with feet just touching the floor can be placed and

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FIG. 1.

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educated in the use of its leg muscles as he traverses the whole length of the room, without the danger or fear of falling. This trolley can be used by a patient either with or without an attendant. (Fig. 4.)

DRESSINGS. Each case requiring surgical dressing, removal of plaster cast, or anything that is likely to cause pain, is removed upon a wheeled litter to a separate room. A closed door intervenes between this room and the ward, and thus is avoided the disturbing element of listening to sounds of pain or fright, which so often cause serious and distressing results in a ward filled with children. In this room are provided all surgical appliances for thorough, aseptic, cleanly dressings, and all mechanical and electrical accessories. Patients requiring frequent dressings are kept upon bed frames, or trays, so as to be easily lifted and transported. During the dressing the tray rests upon enamelled iron trestles (Fig. 3). A large pan placed underneath permits free irrigation through the break in the canvas cover opposite the wound.

A clean pitcher upon a movable stand, with siphon irrigation attachment, is more cleanly and convenient than the ordinary irrigation jar.

RECOVERY-ROOM. In the recovery-room are placed all patients after operation, where they remain as long as absolute quiet is essential. No patient is allowed to be etherized in the ward, nor to return to the ward before recovering from an anæsthetic.

THE MUSCULAR DEVELOPMENT-ROOM AND GYMNASIUM. The muscular development-room is in charge of a competent physical trainer and masseuse who supervises active and passive muscular movements, Swedish exercises, massage, etc. For lateral curvature cases, in addition to the active and passive movements of Roth and others, special gymnastics are provided for special cases—dumb-bells, clubs, double trapeze, unequal rings, quarter circles, chest weights, Swedish bars, etc. (Fig. 3). For adults forcible correction is practised by Weigel's and Beeley's powerful machines. Couches are provided for rest.

For paralytics there is a trolley with corset suspension similar to the one described in the ward, which runs the entire length of the room (Fig. 4). The younger and paralytic children ride a stationary bicycle—their feet being strapped to the pedals—run by an

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electric motor. For this class also a swing moved by the arm-power of the patients is a pleasant and helpful device.

No case is treated without a written prescription giving the exact movements to be employed, the length of time treatment is to be continued, etc., and each case is individually supervised either by the surgeon or attendant.

When there are too many patients for hand massage, mechanical massage is employed by machines, an electric motor furnishing the power. Hand and foot movements are used for stiffened joints following fractures or other injury.

Large cylindrical ovens are furnished also for the treatment by superheated dry air in cases of anchylosis of joints, rheumatism, flat-foot, etc.

ISOLATION-ROOM. To the isolation-room is removed every case of even suspected contagious disease. By early sequestration an outbreak is often checked; if a false alarm has arisen, a day or two settles the question. This room is tiled, and can be easily washed and fumigated; it also has a separate water-supply, so that the nurse need not communicate with other portions of the hospital. Early separation is the essential element in the avoidance of an epidemic.

PRIVATE OPERATING-ROOM AND AMPHITHEATRE. The private operating-room and public amphitheatre are furnished with white marble floors in large blocks, in order best to disclose dirt and avoid cracks. These can be flushed by hose. The floor corners are rounded and the sides of the rooms tiled. Pedal cocks are supplied for the washstands. The rooms are furnished with white enamelled iron and glass.

An electrically heated mattress lies upon the operating-table, supplying a warm and comfortable bed throughout the operation and greatly lessening the shock of prolonged operations or of those which are accompanied by great loss of blood.

STERILIZATION. Sterilized hot and cold water are supplied from the tanks to the private operating-rooms, the public amphitheatre, surgical dressing-room, and dispensary. Instruments, dressings, etc., are sterilized each day.

DISPENSARY. A patient requiring examination or dressing of the feet is placed upon an elevated platform or a high stool,

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FIG. 2.

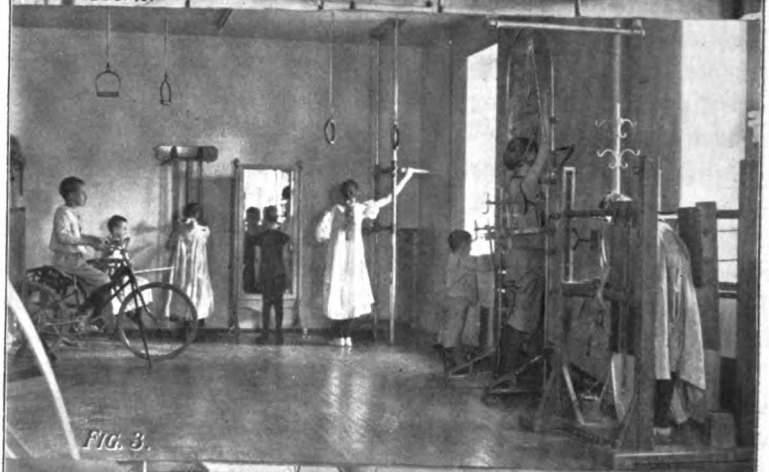

FIG. 3.

FIG. 4.

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thus greatly relieving the vertebral column of the surgeon. This platform is provided with a graduated appliance for measuring inequality of limbs, also with a sloping mirror for inspecting the soles of flat-feet.

MACHINE SHOP. A machine shop for the manufacture of apparatus, including all the steel, leather, and shoe work, is run in connection with the department.

LABORATORY. A laboratory thoroughly equipped for microscopical, chemical, and bacteriological work is also provided.

PHOTOGRAPH AND X-RAY ROOM. A practical room for photography is another important adjunct, and an X-ray outfit is close at hand.

APPARATUS-ROOM. One room is also devoted to the display and storage of various illustrative apparatus, both ancient and modern.

TEACHER. A lady for six hours each day teaches such as are able to learn reading, writing, and arithmetic, sewing, and self-control. She beguiles weary restlessness by stories, teaches quiet games, writes letters for the children, and visits dispensary and ward patients at their homes in the city. Many careless or indigent cases need to be watched over after leaving the hospital.

Finally, sunlight, fresh air, cleanliness, an abundance of nutritious food, and cheerful surroundings, are insisted upon as essentials.

FIG. 1.—Main ward, with sun-porch at south end. Suspension-trolley in ceiling.

FIG. 2.—Dressing-tray laid on trestles. Irrigation through opening.

FIG. 3.—Special orthopædic gymnastic apparatus, stationary bicycle, etc.

FIG. 4.—Orthopædic gymnasium. Suspension-trolley for paralytics, etc.

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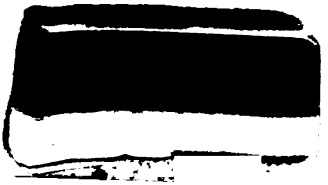

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